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FOOD SAFETY CONSORTIUM

M. Vanier

In recent years, food safety has become an issue of concern for the beef industry, beef processors, and the consuming public. Even though America has the safest and most wholesome food supply in the world, consumers are worried about the safety of the meat they eat. In response to reports of illness from contamination by both microbes and chemicals in the meat supply, the United States Congress, in 1988, authorized and funded a Special Grants Program in the United States Department of Agriculture called the Food Safety Consortium. The members of the Consortium are Kansas State University, the University of Arkansas-Fayetteville and Iowa State University. Each university is charged with performing research to:

- develop technology for the rapid identification of infectious agents and toxins;
- develop a statistical framework to evaluate the potential health risks;
- determine the most effective intervention points at which to control microbiological or chemical hazards;
- develop risk-monitoring techniques to detect potential hazards in the distribution chain;
- reduce or eliminate microbial or chemical hazards associated with production, processing, and distribution.

Each of the universities involved is conducting research to meet the above objectives by concentrating on a different muscle food. With Kansas being one of the nation's largest producers of beef and the largest beef processor, Kansas State's research has focused on these objectives as they relate to the production, processing, packaging, and distribution of beef. The University of Arkansas is emphasizing poultry and Iowa State, pork. This year, the Consortium schools have split funds in excess of $1.7 million.

Kansas State has made significant progress in several areas. Dr. Daniel Fung's laboratory has been extremely active in the study of microbiological isolation, detection, and enumeration. The laboratory has developed a system to rapidly identify certain pathogenic microbes that may be found in beef. This system will provide an inexpensive and rapid method that can be used by processing plant management or inspection officials to identify potential microbial hazards before the product is shipped. The University has applied for a patent on the process.

Dr. Scott Smith's laboratory is investigating the potential for residues of organophosphate pesticides and their metabolites to appear in beef. He is developing techniques to detect levels of these chemicals at various times post-treatment. To accomplish this end, Dr. Smith has equipped his laboratory with some of the most sophisticated analytical equipment available, making it one of the best laboratories of its type in the country.

Drs. Danny Simms, Gerry Kuhl, Dave Schafer, and Bob Larson are researching new identification systems for live cattle and have surveyed currently used identification and drug recordkeeping systems. Their work will be important in 1) helping to identify points in the production chain where hazards may be prevented and 2) providing information to producers on better methods for avoiding residue

problems.

Drs. Curtis Kastner, Melvin Hunt, and Don Kropf have investigated different packaging methods, including modified atmosphere packaging, and various processing methods to determine the points at which contamination may occur or may be prevented. They are also studying how newer types of processing, including low-salt and/or low-fat, and restructuring might affect the growth of pathogenic bacteria. Factors that influence apparent degree of doneness and cooked color are being evaluated, because consumers use color to gauge microbial survival.

Dr. Frank Cunningham's laboratory is testing various combinations of organic acids, antioxidants, enzymes, and other approved food additives that control microbial growth on carcass and product surfaces. These may be useful in reducing the incidence of spoilage and potential pathogens.

These scientists, working with their colleagues both here and at the two other Consortium institutions, are dedicated to finding the answers necessary to keep Kansas beef products the safest and most wholesome in the world.

BEEF SAFETY - CURRENT RESEARCH AND SUMMARY OF PROGRESS[1,2]

F. Cunningham, D. Fung, M. Hunt, C. Kastner, D. Kropf, B. Larson, D. Schafer, D. Simms, S. Smith, and M. Vanier

Beef and beef products are significant parts of a balanced diet in the U.S. and major parts of the Kansas economy. Therefore, these products must be carefully processed, handled, and monitored for microbial quality to ensure safety for the consumer. KSU Animal Sciences research is designed to accomplish this end and to enhance demand for beef. We have made a major commitment to beef safety research. Moreover, results with beef are generally applicable to other meats.

A major objective of our beef safety research is to develop rapid analytical methods for estimating microbial numbers and species in meat and meat products. To achieve this end, Dr. Fung's group has established a Rapid Methods and Automation in Microbiology Center, which develops effective automated methods for monitoring disease-causing microorganisms. We have established that commercially available laser counter instrumentation is very effective for rapid enumeration of microbes on meat samples. Although other publications point to the effectiveness of this system, it was necessary that we evaluate and perfect the system for beef. Since refining this procedure, Dr. Fung's group has applied the system successfully to several projects related to beef safety and processing. The Center has demonstrated the procedure's ability to analyze for the presence and number of potential pathogens in beef and beef products. The microbial profile of a "typical" restructured, precooked, vacuum-packaged, refrigerated product has been evaluated after storage. This type of baseline evaluation is imperative as we develop value-added processes to produce convenient, precooked, beef products. Furthermore, we are utilizing the Omnispec® reflectance colorimetry method to estimate the number of microbes in meat and are developing procedures to study possible pathogens that might be present in beef. Refinement of these techniques will gave the industry improved ability to monitor and ensure the wholesomeness of beef for the consumer. This is particularly important for Kansas, because it enables our packing industry to rapidly monitor the microbial status of beef products before they are shipped to a variety of distant locations. Product recall is expensive and difficult and must be minimized.

We continue to evaluate dye-containing growth media for isolating bacteria, yeasts, and molds from food samples. A Klebsiella pneumoniae medium was developed to effectively isolate and enumerate this potential pathogen from food and the environment. The Candida albicans medium developed in Dr. Fung's laboratory exhibited 98% sensitivity and 99.5% accuracy in isolating and characterizing this important human yeast pathogen. Another of our dye-containing media can specifically isolate Penicillium and Aspergillus from meat

[1]This material is based upon work supported by the Cooperative State Research Service, U.S. Department of Agriculture, under Agreement No. 89-34187-4511.

[2]Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

and other foods. Dr. Fung's laboratory also developed and evaluated Trypan Blue Agar for the enumeration of yeasts and molds. Rapid methods to detect, isolate, and identify Salmonella, Listeria, Campylobacter, Yersinia, Clostridium, and Staphylococcus, which are bacterial pathogens possibly present in beef and beef products, were also developed.

In work on Clostridium perfringens, a double tube system proved superior to all other systems we tested, and we plan to submit this procedure for AOAC (Association of Official Analytical Chemists) approval in the near future. Furthermore Dr. Fung's double tube system has shown promise in effectively recovering Clostridium sporogenes. Research on control of E. coli 0157:H7 by fermentation in meat systems and antioxidants is in progress.

Development of a system for detecting low numbers of facultative anaerobic, motile, bacterial pathogens by using the oxyrase enzyme along with a unique motility enrichment procedure has been successful, and a patent application has been filed. The first organism successfully tested was Listeria monocytogenes. In the presence of oxyrase, Listeria grows very fast and can be detected in 5 to 7 hours, approximately 4 times faster than with other methods. Confirmation of this system through detection of Listeria in food is in progress.

Monitoring the sanitation and quality of air in meat processing areas is a key to maintaining product sanitation. We have presented research outlining our techniques at the 1989 International Association of Milk and Food Environmental Sanitarians meeting in Kansas City. A very simple catalase swab test can ascertain the sanitary condition of surfaces in meat processing plants. If swabbed surfaces of equipment or product are not "clean", catalase present in the microbes will form bubbles when the swab is placed in a hydrogen peroxide solution. This rapid test may be used as a quick indication of relative cleanliness. A major meat processors association is interested in making this test available to its members. More detailed research is under way.

Drs. Kropf and Hunt have evaluated several raw materials and processing parameters for their influence on the color of ground beef patties precooked to selected internal temperatures. Colored photographs of patties representing a range of raw materials, processing parameters, and a range of final internal temperatures surrounding the critical control temperature for Escherichia coli 0157:H7 and its verotoxin have been prepared. Studies are being designed to verify results and determine the best ways to present and utilize this information in the meat and food service industries. This research is critical to the beef industry because of the importance of ground beef; the need to develop convenient, precooked, "fast food" items; and the common practice of using cooked meat color to evaluate degree of cooking.

Dr. Cunningham's group has studied the effect of various foods and food ingredients on the activity of lysozyme, a naturally occurring antimicrobial enzyme. This knowledge can help ensure the safety of meat and meat products and extend shelflife. Lysozyme activity in the presence of seven basic amino acids increased to more than 100% of its original activity. Glucose increased lysozyme activity to 109.7%. Aspartame, a non-caloric sweetener, lowered lysozyme activity. Ingredients commonly used in processed meats, such as mustard, pepper, paprika, smoke, and curing ingredients, either enhanced lysozyme activity or were only slightly inhibitory. The antimicrobials, potassium sorbate or sorbic acid in a 1% solution, slightly decreased lysozyme activity to 95.2%. The antioxidant, n-propyl gallate (PG) decreased lysozyme activity to 85.7%, but 5% flour (91.3% activity) and 5% cornstarch (96% activity) only decreased lysozyme activity slightly. Lysozyme stability in food and food ingredients was studied on a long-term basis. Lysozyme activity remained high over a 1-yr period in solutions of boric acid, salt, sodium benzoate, sodium benzoate mixed with phosphoric acid, ethanol, and glycerol. The minimum concentration of lysozyme or EDTA

(a product that binds metals) that will control Listeria monocytogenes has been determined. However, lysozyme and EDTA work best in combination.

Selected food acids and their salts and antioxidants, singularly or in combination, are being tested. To date, four acids, five antioxidants, and 11 combinations have been tested against Salmonella enteritidis, Salmonella newport, and Salmonella typhimurium. Acetic and lactic acid used alone inhibited all three types of Salmonella. Of the antioxidants used alone, TBHQ showed the most promise. The other four antioxidants, PG, BHT, BHA, and Ethoxyquin showed little effect when used alone. However, when BHA was combined with acetic or lactic acid, we observed synergistic effects. The combinations of BHA-TBHQ and BHA-PG inhibited the Salmonella serotypes. The antioxidant-antioxidant combinations of BHA-PG and BHA-TBHQ, as well as the antioxidant-acid combinations of BHA-acetic acid and BHA-lactic acid, appear to be the most inhibitory.

Microbes pose a much more important health risk than chemical (i.e., pesticide) residues. However, the consumer perceives chemical residue as the most important factor influencing food safety. Therefore, we must have rapid, reliable techniques to detect chemical residues in meat and be able to address consumer and inspection agency questions about their significance. Dr. Smith is developing techniques to detect multiple organophosphate (OP) pesticide metabolites in animal tissues. His overall objective is to identify the formation of and measure the depletion of major organophosphate (OP) metabolites in meats. To measure these compounds, a method was needed to detect both the parent molecule, the oxidized parent molecule (oxon), and the hydrolysis metabolite.

Preliminary results show that at least 13 common OP's can be separated and detected. This method (high performance liquid diromatography) is simple and straightforward. Results to date with several OP's indicate that their oxons and hydrolysis products can be assayed using the same analytical method, leading to the probability that all CP compounds can be monitored with one procedure. Additional studies are underway, testing an extraction procedure to recover OP's and their metabolites from liver and cooked tissues.

To address questions about the industry's ability to monitor animal health care and maintain animal identity, Drs. Schafer, Simms, and Larson have combined efforts to evaluate identification and drug record-keeping systems for cattle. Over 340 completed questionnaires representing approximately 1.0 million cattle have been received to evaluate identification methods and success rates in Kansas. Approximately 75% of the respondents use brands and 80% use ear tags. Over 70% of the respondents reject the idea of a universal cattle identity system. Even though most questionnaires have been summarized, more are being solicited, and the final report will include that information.

Two companies that sell implantable electronic identification devices have agreed to research trials with their product and negotiations are underway with a third. The original trials will test the ease of administration, animal tolerance, and product features. We are interested in how far away the device can be read, if information can be added to the implants, the features of the peripheral computer programs, and practicality. Following FDA approval, we plan to use up to 150 of each company's devices in calves and follow them through to slaughter. Future tests may include devices that not only identify animals, but also measure indices such as body temperature and respiration rate. The technology for measuring body temperature with an implant device is close to commercial availability. Such a device could allow early detection of fevers and earlier treatment with less medication, leading to a reduction in residue concerns. Electronic identification could also allow automated collection of production, genetic, and health data. For tracing purposes, this semi-permanent identification system would also provide an

accurate history of animal ownership.

Interviews of feedlot managers and employees in Southwest Kansas determined that both microcomputer and manual record-keeping systems are used to keep track of pharmaceutical use. The vast majority of yards depend on custom feeding for their livelihood. Yard managers are acutely aware of economic repercussions to their customers, if residues are detected. Therefore, they are very cautious in following label-prescribed withdrawal times. Microcomputer software packages are available that allow feedlots to monitor such items as treatments, withdrawal times, drug inventory, and animal inventory. Pharmaceuticals represent a significant operating expense for feedlots. Programs that carefully monitor product usage help guarantee proper customer billing, and from a residue avoidance point of view, help assure that all treated animals are recorded.

Employees are aware that all drug inventory must be accounted for with treatment records. Feedlot managers were generally pleased that computer use has been well received by feedlot employees.

Companies selling pharmaceutical treatment software packages were contacted for the names of feedlots using their respective packages. Then, 72 yards in Kansas and Nebraska were surveyed. Survey questions addressed advantages and disadvantages of the packages and evaluated their usefulness as tools to aid in avoiding residues. This survey information is being summarized.

A questionnaire addressing general record-keeping systems used by Kansas feedlot operations has been mailed. Questions are geared to discovering manager's concerns and potential problems with record keeping systems. From the 232 yards surveyed to date, 55 questionnaires have been returned and a resurvey is in progress.

Kansas State University has made significant progress toward its research goals of developing technology for rapid identification of microbial and chemical agents and analyzing the food chain to determine the most effective points at which to prevent contamination. The knowledge gained from this research will continue to enhance beef's role in the American diet.

BINDING AGENTS FOR LOW-SALT, LOW-FAT, RESTRUCTURED BEEF ROASTS: FISH SURIMI AND BEEF HEART OR SKELETAL MUSCLE

P. B. Kenney, C. L. Kastner, and D. H. Kropf

Summary

Five percent fish surimi, unwashed or washed ground beef, and washed or unwashed beef hearts were evaluated in precooked, chunked and formed, restructured beef roasts to determine if they would increase bind in low-salt (0.2% NaCl) product. An industry-like product with 1.0% NaCl and 5% unwashed ground beef was prepared, as well as a product with 0.2% NaCl and no binder. Roasts without binder were comparable in texture and integrity to those prepared with binding agents. Washing ground heart improved the sensory traits, texture measured instrumentally, and oxidative stability of the resulting products. Color was more stable for roasts containing ground heart. Roasts with 1.0% NaCl were firmer ($P < .05$) and had greater tensile strength ($P < .05$) than all other treatments. Adding salt increased binding more than adding binders, even though acceptable products could be made with minimal salt. Using binders with or without washing is not recommended, unless processors want to expand use of beef hearts.

(Key words: Restructured, Beef, Low-salt, Bind, Muscle Washing.)

Introduction

As a result of greater concern over fat and its impact on coronary heart disease and because of consumer health concerns, emphasis has been placed on technology to produce low-salt, low-fat, meat products. But when salt is reduced in restructured products, processing and texture problems may arise. These effects can be partially overcome through the use of phosphates. More recently, fish surimi, a protein concentrate prepared from mechanically deboned fish, has been utilized as a binder. However, the cattle industry could benefit if a binder could be made from beef. Our experiment was designed to study the feasibility of manufacturing low-salt, low-fat, precooked, beef products; to determine if washing ground beef and hearts would improve their utility as binding adjuncts; and to determine if, in fact, binders are necessary in restructured roasts.

Experimental Procedures

Beef skeletal muscle from inside rounds and hearts (cardiac muscle) were separately ground through a one-eighth inch plate and mixed for 15 min with 5 volumes of tap water. Then the slurry was allowed to stand for 30 min. Water was decanted and the remaining residue was wrapped in cheesecloth and manually pressed to remove additional water. Total volume of water thus removed was recorded, then an equal volume of fresh water was added back, and the process was repeated. Following the second filtering and pressing, the residue was centrifuged, and the same levels of phosphate and sugar that were present in fish surimi were added as cryoprotectants.

Commercial fish surimi and the washed and unwashed ground beef skeletal muscle and hearts were each mixed with 4.0% salt, and the moisture content was standardized; then the binder blends were stored for 12 h at 38 to 40°F. Three major muscles from A-maturity beef chucks were manually trimmed of connective tissue and fat, chunked through a kidney plate, and stored for 12 h at 38 to 40°F. Then 5% binder was mixed with 95% muscle chunks, resulting in .2% salt in the raw product. Two additional treatments were evaluated: 1) 100% chunks, no binder, .2% NaCl; and 2)

95% chunks, 5% unwashed skeletal muscle, 1.0% NaCl. After air was evacuated the material was stuffed into #6, prestuck, fibrous casing and cooked to 147°F.

Proximate composition, instrumental and sensory texture, sensory flavor. and fat stability of the finished products were evaluated. Mineral content of each binder was measured.

Results and Discussion

Moisture ranged from 71 to 72%, fat from 3.9 to 4.3%, protein from 22 to 24%, and ash from 1.4 to 2.3% for cooked products. Products with 5% unwashed skeletal muscle and 1.0% NaCl (USM/1.0) had the highest ($P < .05$) Instron hardness, cohesiveness, and tensile strength values (Table 1). Although 1.0% NaCl was not sufficient to solubilize myosin, it did promote enough hydration for protein-water and protein-protein interactions during cooking to preserve structural integrity. Sensory evaluation (Fig. 1) showed that the product with 1.0% NaCl was firmer ($P < .05$) and more brittle than those of other treatments. At the 0.2% NaCl level (Fig. 1), products without binder (0/0.2)) were firmer ($P < .05$) than products with unwashed cardiac (heart) muscle (UCM/0.2) and commercial fish surimi (FS/0.2). Products without added binder (0/0.2) also had higher tensile strength (Table 1) than products with unwashed ground heart (UCM/0.2). Washing heart muscle increased ($P < .05$) firmness compared to unwashed cardiac muscle. Both unwashed and washed ground heart increased ($P < .05$) bloody-serumy flavor (Fig. 2) compared to all products, except those containing fish surimi. Higher TBA (thiobarbituric acid) numbers are an indication of more fat rancidity. Washing reduced ($P < .05$) 24-h TBA numbers (Fig. 3); however, those products still had higher ($P < .05$) TBA numbers than all other products, except those made without binder. Higher bloody-serumy scores and TBA numbers for heart (cardiac muscle) may be the result of higher iron levels; iron contributes to metallic flavor and acts as a prooxidant. Unwashed and washed heart contained 49 and 31 µg of iron per gm of tissue, respectively, compared to 23 µg/g for unwashed skeletal muscle, 7.3 µg/g for washed skeletal muscle, and 4.3 µg/g for fish surimi.

High (1%) salt was more effective in improving texture than any of the other treatments. All low-salt (0.2%) products had acceptable texture, even without binder addition. Muscle washing and binder addition are not necessary, unless the processor wants to expand the use of beef hearts.

Table 1. Instron Tensile Strength, Hardness, and Cohesiveness of Precooked, Restructured Beef Formulated with Either .2 or 1.0% NaCl and Either with or without Unwashed and Washed Skeletal (USM and WSM) and Cardiac (UCM and WCM) Muscle and Fish Surimi (FS)

Treatment	Tensile strength (gm/cm^2)[a]	Hardness (KG)[b]	Cohesiveness[c]	Cook yield (%)
USM/.2	421.3[ef]	24.8[de]	28.6[d]	91.0[d]
WSM/.2	474.5[f]	25.6[de]	33.0[d]	94.2[e]
UCM/.2	342.9[d]	24.9[de]	27.4[d]	93.1[de]
WCM/.2	438.2[ef]	26.8[de]	30.9[d]	91.6[de]
FS/.2	380.1[de]	22.9[d]	33.2[d]	94.2[e]
0/.2	443.0[ef]	29.5[e]	29.9[d]	91.9[de]
USM/.0	637.0[g]	42.2[f]	43.4[e]	92.6[de]

[a]Tensile strength.
[b]Peak force of first compression to 50% of height.
[c](Total energy of second compression/total energy of first compression) × 100.
[defg]Columns only ($P < .05$).

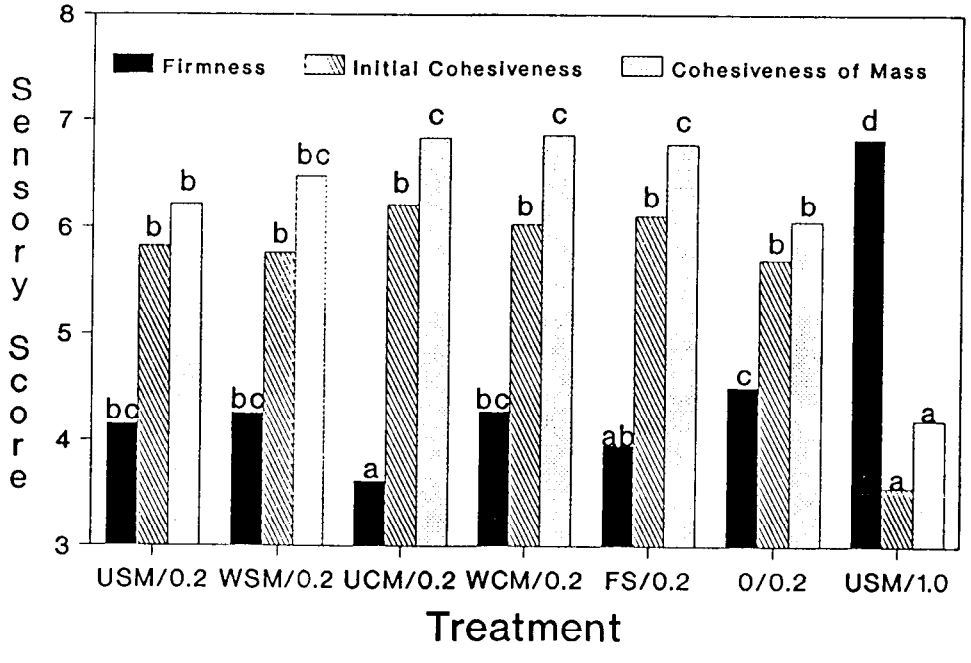

Figure 1. Sensory Textural Attributes of Precooked, Restructured Beef Formulated with Either .2% NaCl or 1.0% NaCl and Either with or without Unwashed and Washed Skeletal (USM and WSM) and Cardiac (UCM and WCM) Muscle and Fish Surimi (FS). ([abcd]$P < .05$).

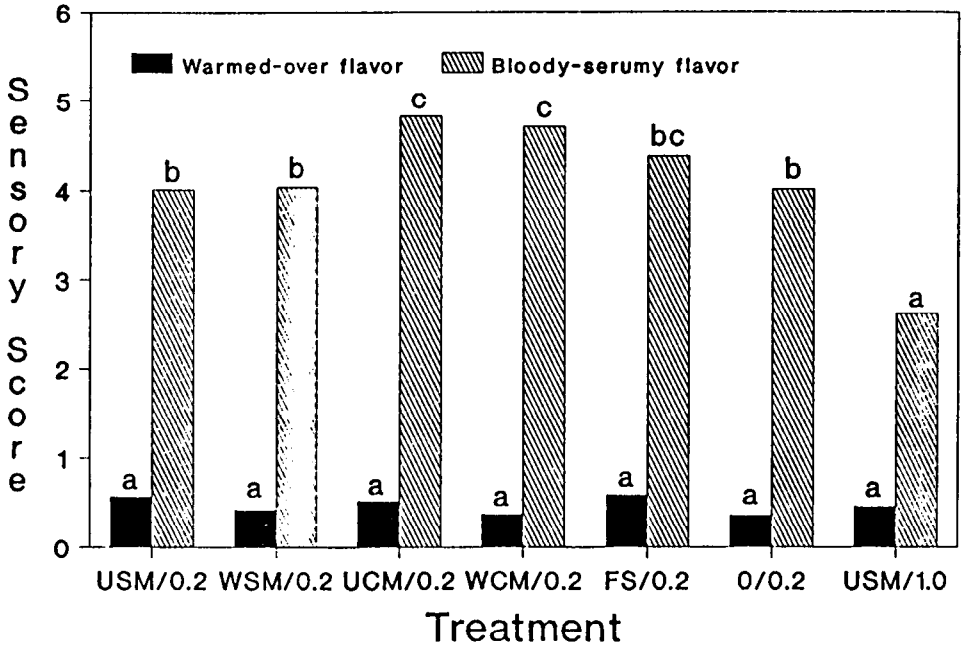

Figure 2. **Sensory Flavor Attributes of Precooked, Restructured Beef Formulated with Either .2 or 1.0% NaCl and Either with or without Unwashed and Washed Skeletal (USM and WSM) and Cardiac (UCM and WCM) Muscle and Fish Surimi (FS) ($^{abc}P<.05$).**

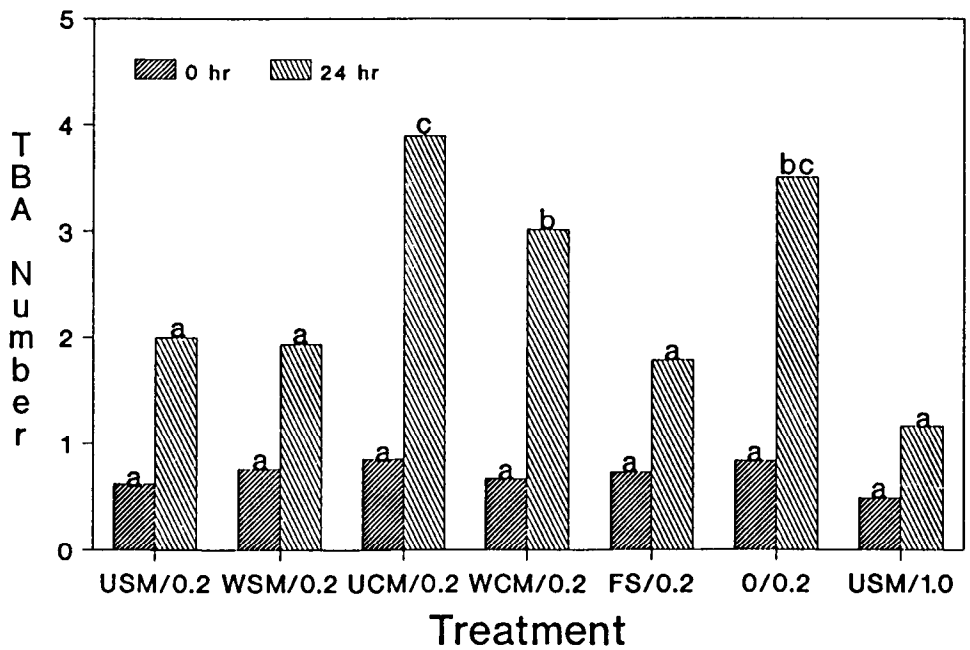

Figure 3. **TBA Numbers (µg malonaldehyde/g) of Precooked, Restructured Beef Formulated with Either .2 or 1.0% NaCl and Either with or without Unwashed and Washed Skeletal (USM and WSM) and Cardiac (UCM and WCM) Muscle and Fish Surimi (FS) ($^{abc}P<.05$).**

BINDING AGENTS FOR LOW-SALT, LOW-FAT, RESTRUCTURED BEEF ROASTS: CONNECTIVE TISSUE OR GELATIN

P. B. Kenney, C. L. Kastner, and D. H. Kropf

Summary

Connective tissue, from the outside of three major chuck muscles, was evaluated for binding properties when incorporated either raw or following preheating into precooked, restructured beef. Food-grade gelatin was also evaluated as a binding agent. Adding 10% raw or preheated connective tissue increased ($P < .05$) instrumentally measured tensile strength and reduced ($P < .05$) juiciness perception. One percent gelatin reduced ($P < .05$) cook yields and increased ($P < .05$) tensile strength but not to the degree of 10% raw or preheated connective tissue. Preheating had minimal effects on improving connective tissue utility. Based on the improvement in bind and cook yields, use of connective tissue as a binder is feasible in manufacturing low-salt, precooked, restructured beef.

(Key Words: Restructured beef, Connective tissue, Gelatin, Tensile strength.)

Introduction

Connective tissue can decrease the desirability of restructured meat texture. However, during cooking, connective tissue collagen is converted to gelatin that may contribute to bind in meat cold-cuts because it will gel when chilled. Consequently, this study was conducted to determine if adding either food-grade gelatin or connective tissue trim pulverized in liquid nitrogen could increase bind in low-salt, restructured beef.

Experimental Procedures

Three major muscles from A-maturity beef carcasses were trimmed of fat and outside connective tissue, ground through a kidney plate, mixed with .51% tetrasodium pyrophosphate (TSPP) and stored at 39 °F for 12 hr. The connective tissue trim was pulverized in liquid nitrogen. A portion was used raw and another portion was heated to 143 °F. At the end of a 12 hr preblending period, products were formulated to contain 0.2% NaCl and 0.5% TSPP and either no binding agent (control), 0.5% or 1.0% gelatin, 5.0% or 10.0% raw connective tissue, or 5.0% or 10.0% preheated connective tissue. Products were stuffed into fibrous, prestuck casings and cooked to 146°F. Proximate composition and soluble, residual, total, and percent soluble collagen were determined for raw and cooked product. Instron hardness, cohesiveness, and tensile strength were measured. Sensory panel scores for tensile strength (0 = very easy to pull apart to 10 = very difficult to pull apart), firmness (0 = not firm to 10 = very firm), initial cohesiveness (0 = clean break to 10 = high deformation), cohesiveness of mass (0 = low cohesiveness to 10 = high cohesiveness), beefiness (0 = none to 10 = intense), and juiciness (0 = not juicy to 10 = very juicy) were assessed as well. Data were analyzed as a randomized complete-block design and means were separated using least-square procedures.

Results and Discussion

No differences ($P > .05$) in proximate composition were detected. Moisture ranged from 71 to 72%, fat from 4.0 to 5.0%, protein from 22 to 23%, and ash from .95 to 1.4%. Neither total or soluble collagen contents

differed ($P > .05$) for cooked products with 1.0% gelatin, 10% raw connective tissue, or 10% preheated connective tissue (Table 1). Soluble and total collagen contents of the control were .80 and 4.73 mg/g, respectively, and were less ($P < .05$) than those for all other treatments. Products with 10% raw and preheated connective tissue contained 5.98 and 5.55 mg of residual collagen per gm compared to 3.93 mg/g for the control ($P < .05$). Residual collagen contents of other treatments were similar ($P > .05$) to the control. Compared to the control, Instron hardness was greater ($P < .05$) for products with 10% raw connective tissue. All binder treatments except 0.5% gelatin increased ($P < .05$) Instron tensile strength over the control (Table 2). Although products with 1.0% gelatin or 10% raw or preheated connective tissue had significantly more soluble collagen than the control, the dramatic increase in tensile strength appeared to be more strongly related to residual collagen content. Adding 10% raw or preheated connective tissue reduced ($P < .05$) juiciness scores and tended ($P < .09$) to reduce beefiness scores compared to the control (Table 3). Adding 10% raw connective tissue increased ($P < .05$) cook yields to 90.7% compared to 90.0% for the control, whereas 1.0% gelatin reduced cook yields to 88.1% (Table 2).

This study demonstrates that connective tissue can be removed, altered, and reincorporated with beneficial effects on bind and cook yields of low-salt, precooked, restructured beef. Even though 10% addition of raw or preheated connective tissue tended to reduce product juiciness and beefiness, it dramatically increased tensile strength. That may prove significant in precooked products with salt levels too low for optimal use of meat proteins and may expand the use of low cost, high connective tissue, raw materials.

Table 1. Residual, Soluble, Total, and Percent Soluble Collagen of Precooked Restructured Beef as Affected by Gelatin (G) and Raw (CT) and Preheated (PHCT) Connective Tissue[a]

Treatment	Residual (mg/g)	Soluble (mg/g)	Total (mg/g)	Soluble (%)
Control	3.93[a]	.80[a]	4.73[a]	17.37[a]
.5 G	3.95[a]	2.89[b]	6.84[b]	40.97[bcd]
1.0 G	4.36[a]	4.78[c]	9.14[c]	51.57[d]
5 CT	4.72[ab]	2.14[b]	6.86[b]	30.46[b]
10 CT	5.98[c]	4.23[c]	10.22[c]	41.25[cd]
5 PHCT	4.21[a]	2.95[b]	7.16[b]	40.65[bc]
10 PHCT	5.55[bc]	4.60[c]	10.15[c]	45.38[cd]

[abcd]Columns ($P < .05$).

Table 2. Instron Hardness (H), Cohesiveness (C), Tensile Strength (TS), and Cook Yield (CY) of Precooked, Restructured Beef with and without .5 and 1.0% Gelatin (G) and 5 and 10% Raw (CT) and Preheated (PHCT) Connective Tissue[a]

Treatment	H (KGF)	C	TS (g/cm^2)	CY (%)
Control	23.14^{ab}	34.48^{c}	515.53^{a}	90.0^{bc}
.5 G	21.77^{a}	26.34^{ab}	615.56^{ab}	89.3^{b}
1.0 G	22.33^{ab}	23.50^{a}	698.28^{bc}	88.1^{a}
5 CT	24.75^{ab}	31.02^{bc}	689.97^{bc}	90.7^{cd}
10 CT	31.22^{c}	34.56^{c}	806.53^{c}	90.9^{d}
5 PHCT	23.14^{ab}	27.55^{ab}	656.14^{a}	90.1^{bcd}
10 PHCT	26.02^{b}	29.26^{b}	810.56^{c}	90.0^{bc}

[abcd]Columns only ($P < .05$).

Table 3. Sensory Assessment of Low-fat, Precooked, Restructured Beef with and without .5 and and 1.0% Gelatin (G) and 5 and 10% Raw (CT) and Preheated (PHCT) Connective Tissue

Treatment	Tensile strength	Firmness	Initial cohesiveness	Cohesiveness of mass	Juiciness	Beefiness
Control	4.13^{a}	4.04^{a}	6.96^{b}	7.48^{c}	7.28^{c}	7.00^{a}
.5 G	4.17^{a}	3.85^{a}	6.13^{ab}	6.96^{abc}	6.54^{bc}	6.31^{a}
1.0 G	4.72^{a}	4.63^{a}	5.57^{ab}	6.09^{abc}	5.26^{ab}	5.41^{a}
5 CT	4.31^{a}	3.74^{a}	6.04^{ab}	7.22^{bc}	6.54^{bc}	6.56^{a}
10 CT	5.67^{a}	5.15^{a}	4.87^{a}	5.61^{a}	4.81^{a}	5.26^{a}
5 PHCT	4.37^{a}	3.93^{a}	5.59^{ab}	6.28^{abc}	5.69^{ab}	5.69^{a}
10 PHCT	4.61^{a}	4.17^{a}	5.05^{a}	6.07^{ab}	4.70^{a}	5.17^{a}

[abc]Columns only ($P < .05$).

UTILIZATION OF NEAR INFRARED REFLECTANCE SPECTROSCOPY FOR PREDICTION OF THE NUTRITIONAL COMPOSITION OF BEEF AND PORK SAMPLES

G. Garcia-Lagombra, L. H. Harbers, J. Velazco, J. L. Morrill, B. B. Maziya, and C. A. Z. Harbers

Summary

Near-infrared reflectance spectroscopy (NIRS) offers the potential for rapid, low-cost analyses of meat samples. Beef and pork samples were analyzed by both standard laboratory (AOAC) methods and NIRS. Regression equations were developed to relate the two methods. Coefficients of determination between NIRS and AOAC results were .929 for dry matter, .965 for crude protein, and .996 for ether extract. NIRS and AOAC procedures yielded very similar results (DM, 38.82 vs 38.58; CP, 17.78 vs. 17.83; and EE, 18.83 vs. 18.00). NIRS appears to be a rapid and reliable predictor of nutritional composition of ground beef and pork based on regression equations we have developed with a limited number of samples.

(Key Words: Near Infrared Reflectance Spectroscopy, Pork/Beef Equations)

Introduction

NIRS has been used extensively for determining of the nutritional composition of forages and grain. That technology has also been extended to food products, such as meats and milk. We decided to apply NIRS to ground beef and pork. Regression equations have been developed for pork, beef, and beef/pork together. Results from the combined equations are presented in this article.

Experimental Procedures

Eighty-four, commercial, lean and fat, pork samples were processed through a Hobart Grinder and scanned in duplicate with a Pacific Scientific 4250 NIRS instrument. Twenty calibration samples chosen by a subset program plus a set of validation samples chosen at random were analyzed by AOAC methods for dry matter (DM), crude protein (CP), and ether extract (EE).

Beef samples were collected from an experiment involving Holstein steers of different ages and sizes. Beef samples were processed similarly to the pork samples. Twenty eight samples were scanned in duplicate and a subset of 17 was selected as calibration samples. Validation samples were chosen at random.

The spectra of all the samples were then matched to the AOAC laboratory data for the calibration and validation samples. Seven calibrations were necessary to obtain the final predictive regression equations for DM, CP, and EE. Selection of final equations was based on a combination of factors such as the highest R^2 (coefficient of determination) and the lowest standard error of calibration. All samples with AOAC laboratory data were compared to data from NIRS equations to predict how well the systems matched in determining the nutritive value of beef and pork.

Results and Discussions

The beef/pork regression equations contained two terms for DM, three for CP, and four for EE. The DM information was found around wavelengths 2040 and 1995; CP around 1944, 2053, and 2201; and EE around 2057, 2295, 2044, and 2067. The equations are now available for use in our instrument. The coefficients of determination (R^2) for calibration samples (Table 1) indicate that NIRS has excellent potential for predicting the nutritional value of beef/pork (DM = .928, CP = .964,

EE = .996). Validation samples are independent samples not used in developing the equations. The R^2 values for those samples for the same nutrients were .920, .957 and .993, respectively, confirming excellent prediction capabilities.

The statistical results in Table 2, in which NIRS results (calculated from the beef/pork regression equations we derived) and the AOAC laboratory values were compared, showed a very good agreement. The success of our equations is also confirmed by the means of NIRS and wet chemistry results. All means were very similar.

Table 1. Means, Standard Errors, and Correlations of the Best Beef/Pork Equations.

			Calibration		Validation	
Variable	No. Samples	Means	SE	R^2	SE	R^2
DM	30	38.753	3.531	.928	3.410	.920
CP	35	17.625	.780	.964	.648	.957
EE	30	18.976	1.103	.996	.977	.993

SE = Standard Error.
R^2 = Coefficient of Determination.

Table 2. Comparison of the NIRS Beef/Pork Predicted Values vs. the Laboratory Values

Variable		Mean	SD[a]	N[b]	SE[c]	R^2
Lab values	DM	38.58	12.821	35	3.376	.929
NIRS analyses	DM	38.82	12.360			
Lab values	CP	17.83	3.889	44	.719	.965
NIRS analyses	CP	17.78	3.780			
Lab values	EE	18.00	16.180	35	.991	.996
NIRS analyses	EE	18.03	16.105			

[a]SD = Standard Deviation.
[b]N = Number of Samples.
[c]SE = Standard Error of Prediction.

VALIDATION OF REAL-TIME ULTRASOUND TECHNOLOGY FOR PREDICTING FAT THICKNESSES AND RIBEYE AREAS OF BRANGUS BULLS FROM FOUR MONTHS TO TWO YEARS OF AGE[1]

D. N. Waldner[2], M. E. Dikeman, R. R. Schalles, W. Olson, P. Houghton[3], J. A. Unruh, and L. R. Corah

Summary

Sixty Brangus bulls were evaluated live with two real-time ultrasound instruments to estimate ribeye area (REA) and 12th rib fat thickness (FT) every 4 mo beginning at 4 mo and 12 mo of age, respectively, and continuing until 24 mo of age. At each evaluation period 10 bulls were slaughtered to determine actual REA and FT. Scanned mean FT was accurate ($P < .05$) at 16 mo and was not different ($P = .09$) from the actual mean FT. Scanned mean REA was accurate ($P < .05$) at 12 mo. Absolute differences between scanned and actual mean FT and REA were different ($P < .05$) from zero for all main effects. Increased level of operator (scanner) skill did not improve accuracy of FT or REA measurements, whereas increased level of interpreter (reader) skill improved accuracy of REA measurements. There was no difference ($P > .05$) between the two ultrasound units in accuracy of estimating FT or REA. Scanned measurements overestimated bulls with less than .20 in FT and greater than 13.6 in^2 REA and underestimated bulls with more than .40 in. FT and less than 12.0 in^2 REA. We conclude that REA scanned at 12 mo and FT at 12 or 16 mo were sufficiently accurate to characterize groups of young bulls; however, individual scans were inaccurate. Scanning at other months was not accurate for either individuals or groups of young bulls.

(Key Words: Bulls, Ultrasound, Ribeye Area, Fat Thickness.)

Introduction

Ultrasound technology appears to have considerable potential as a non-destructive, practical, and relatively inexpensive method for determining muscle and fat development in live animals. Some researchers have found ultrasound measurements of fat thickness (FT) and ribeye area (REA) to be quite accurate, whereas other researchers have concluded otherwise. Differences in equipment, operator skill, hide, haircoat, weight, and fat level have all been suggested as possible contributors to these varied results and have led some researchers to determine that many ultrasound instruments are not accurate or consistent enough for use in research or industry application.

The objectives of our study were: 1) to validate real-time ultrasound instruments and technicians for accuracy and(or) precision in measuring REA and FT in Brangus bulls of varying ages; 2) to determine the age to most accurately measure REA and FT; and 3) to determine the compositional changes that occur in the first 2 years of bulls' lives.

Experimental Procedures

Sixty Brangus bulls were evaluated live with

[1]Appreciation is expressed to Brinks Brangus, Eureka, KS and International Brangus Breeders Association, San Antonio, TX, for partial funding of this study.
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real-time ultrasound to estimate REA and 12th rib FT every 4 mo beginning at 4 mo and 12 mo of age, respectively, and continuing until 24 mo of age. At each evaluation time, 10 bulls were slaughtered to determine actual REA and FT. Bulls were scanned with both Aloka "Technicare" 210DX (TC) and Equisonics LS-300A (EQ) real-time, B-mode, ultrasound scanners. Slaughter groups were scanned by four technicians (identified as A, B, C, and D) with various levels of experience. Scans for REA and FT were taken by each technician on each individual slaughter animal, using both the TC and EQ instruments. Images of REA and FT were recorded on video tape. Each technician interpreted all images he or she made. Fat thickness was measured directly utilizing the internal caliper on the ultrasound units at a point interpreted by each technician to be three-fourths the length of the ribeye.

Hip height (HH) and weight (LW) of each animal were recorded every 2 mo. Only REAs were obtained on the 4 mo and 8 mo slaughter cattle because FT at those ages were essentially nil. Both REA and FT were evaluated on all subsequent slaughter groups. Carcass data were obtained by experienced personnel who were not involved in the ultrasound evaluations. Mean actual differences and absolute (average difference from actual ignoring whether the difference was above or below the actual) differences between scanned REA and FT and actual REA and FT were determined. These values were then analyzed over all bulls to obtain least squares means for the main effects and interactions.

Results and Discussion

Estimation of Fat Thickness. In the analysis of actual differences between scanned and actual FT, there were significant differences among all four scan periods (Table 1). Estimation of FT was most accurate ($P < .05$) at 16 mo; estimation at 12 mo was next in accuracy. Month 16 was the only month in which the mean difference of the scanned versus actual carcass measurements was not significantly different from zero ($P = .09$). When the actual differences were plotted against actual FT, there was a trend to overestimate bulls with less than .20 in. FT; as FT increased above .40 in., FT was increasingly underestimated. Therefore, it appears that ultrasound-scanned FT was most accurate in the range of .20 to .40 in., which corresponds to 12 to 16 mo in these bulls. When absolute differences between the scanned and actual carcass measurements for FT were taken into account, all months were significantly different from zero. These data point out that, although real-time ultrasound accurately estimated the average FT at 16 mo for a group of bulls, the measurement can be quite inaccurate for any one animal.

Increased level of operator skill in obtaining images did not improve accuracy of FT estimates. There were no differences ($P < .05$) between EQ and TC units for either actual or absolute differences. At 12 and 16 mo, the most accurate time to measure FT in this study, ultrasound FT was within .12 in of actual FT 95% of the time, whereas over all slaughter periods, ultrasound FT was within .40 in of actual FT 96% of the time (Table 2).

Estimation of REA. In the analysis of actual differences between scanned and actual REA, estimation of REA was accurate ($P = .115$) at 12 mo; at all other months, measurements were inaccurate (Table 3). Except for month 16, when actual differences are plotted against actual REA, bulls with less than about 12.0 in^2 of REA were under-estimated, whereas bulls with greater than about 13.6 in^2 of REA were overestimated. Therefore, ultrasound scanned REA was most accurate in the range of 12.0 to 13.6 in^2, which corresponds to 12 mo for these bulls. When absolute differences between scanned and actual REA were analyzed, all months were different ($P < .001$) from zero. These data suggest that real-time ultrasound can be used to accurately estimate the average REA only at 12 mo of age for a group of bulls; however, the estimate can be quite inaccurate for any one animal. Increased level of skill of the operator obtaining images did not improve the accuracy of REA es-

timates. Interpreter effects are somewhat confounded in that interpreter B (experienced) and interpreter D (inexperienced) were not significantly ($P > .05$) different from each other for actual differences; however, only interpreter B was not significantly different from zero ($P = .602$). Interpreter D, however, had greater variation in measurements as exhibited by a greater absolute difference and was different ($P < .05$) from the other interpreters. All interpreters were significantly different from zero for absolute differences. The EQ unit appeared to be more accurate ($P < .05$) than the TC unit for measuring REA and was not significantly different from zero for actual differences ($P = .395$) However, when absolute differences were taken into account, there was no difference between instruments, and both were significantly different from zero. At 12 mo, the most accurate time to measure REA, ultrasound REA was within 3.0 in^2 of actual REA 95% of the time, whereas over all slaughter periods, ultrasound REA was within 4.0 in^2 of actual REA 95% of the time (Table 4).

We conclude that REA scanned at 12 mo and FT at 12 or 16 mo were sufficiently accurate to characterize groups of bulls, but individual measurements were quite inaccurate. Measurements at other months should not be considered accurate for either individual bulls or groups of bulls.

Table 1. Probabilities that Actual and Absolute Differences for Scanned vs Actual Fat Thickness Are Equal to Zero for Month, Operator, and Instrument

Trait	Actual FT, in	Scanned FT, in	Actual difference	Probability actual difference = 0	Absolute difference	Probability absolute difference = 0
Month						
12	.20	.17	-.03[b]	.000	.05[a]	.000
16	.16	.17	.01[a]	.093	.05[a]	.000
20	.46	.33	-.13[c]	.000	.15[b]	.000
24	.76	.43	-.26[d]	.000	.26[c]	.000
Operator						
A	.37	.25	-.12[b]	.000	.14[b]	.000
B	.37	.39	-.09[a]	.000	.12[a]	.000
C	.37	.39	-.09[a]	.000	.12[a]	.000
D	.37	.39	-.09[a]	.000	.12[a]	.000
Instrument						
Equisonics	.37	.39	-.10[a]	.000	.12[a]	.000
Technicare	.37	.38	-.11[a]	.000	.13[a]	.000

[abcd]Differences within a trait and within a column with a different superscript letter are significantly different ($P < .05$).

Table 2. Percentage of Time that Fat Thickness Is within Designated FT Values over All Slaughter Groups and for 12 and 16 Mo Groups

	Cumulative percent		
± Inches	All groups	12 mo	16 mo
.04	49	39	38
.08	67	71	78
.12	80	95	95
.16	85	100	99
.20	86		100
.24	89		
.28	91		
.32	92		
.36	93		
.40	96		
> .40	100		

Table 3. Probabilities that Actual and Absolute Differences for Scanned vs Actual REA (in^2) are Equal to Zero for Month, Operator, Interpreter, and Instrument

Trait	Actual LM area	Scanned LM area	Actual difference	Probability actual difference = 0	Absolute difference	Probability absolute difference = 0
Month						
4	6.24	4.78	-1.44[c]	.000	1.47[b]	.000
8	7.70	6.56	-1.18[c]	.000	1.62[bc]	.000
12	11.44	11.34	0.13[a]	.115	1.22[a]	.000
16	13.84	12.18	1.60[c]	.000	1.78[c]	.000
20	14.67	15.39	0.70[b]	.000	1.71[c]	.000
24	15.92	17.37	1.38[d]	.000	2.40[d]	.000
Operator						
A	11.55	11.44	-0.19[a]	.002	1.66[a]	.000
B	11.55	11.14	-0.54[c]	.000	1.71[a]	.000
C	11.55	11.14	-0.46[bc]	.000	1.74[a]	.000
D	11.55	11.34	-0.30[ab]	.000	1.67[a]	.000
Interpreter						
A	11.55	10.82	-0.80[b]	.000	1.44[a]	.000
B	11.55	11.65	0.03[a]	.602	1.62[b]	.000
C	11.55	12.16	-0.94[b]	.000	1.54[ab]	.000
D	11.55	11.86	0.19[a]	.004	2.19[c]	.000
Instrument						
Equisonics	11.55	11.65	-0.05[a]	.395	1.74[a]	.000
Technicare	11.55	11.92	-0.72[b]	.000	1.65[a]	.000

[abcde]Differences within a trait and within a column with a different superscript letter are significantly different ($P < .05$).

Table 4. Percentage of Time that Ribeye Area Is within Designated Values of Actual REA for All and 12 Mo Groups

	Cumulative percent	
± Inches^2	All groups	12 mo
.25	12	15
.50	22	31
.75	29	40
1.00	38	53
1.25	46	62
1.50	56	73
1.75	63	77
2.00	71	83
2.50	81	90
3.00	88	95
3.50	92	98
4.00	95	99
> 4.00	100	100

EFFECT OF FEEDING RUMEN-ESCAPE LIPID TO POSTPARTUM BEEF HEIFERS[1]

C. W. Peters, L. R. Corah, and R. C. Cochran

Summary

Feeding .25, .5, or 1 lb/d of rumen-escape lipid in a range supplement to beef heifers after calving resulted in increased calf weight gain and milk production at 70 d postpartum compared to control or feeding 2 lb daily. As level of rumen-escape lipid increased, plasma cholesterol and triglycerides also increased when measured after 14 and 28 d of lipid feeding. The interval from parturition to standing estrus generally was longer as level of rumen-escape lipid increased. It appears that intermediate levels (.25, .5, or 1 lb/d) of rumen escape lipid can enhance milk production and calf weight gain; however, the interval to estrus may be prolonged.

(Key Words: Rumen-Escape Lipid, Beef Heifers, Postpartum Estrus, Milk, Cholesterol.)

Introduction

Maintaining a yearly calving interval and having cows conceive early in the breeding period are important economic goals for beef producers. Cows that conceive early in the breeding period wean older, heavier calves. To achieve early conception, cows must be cycling at the start of the breeding period, and this depends on optimum nutritional management. A short interval from calving to estrus is essential for optimal reproductive efficiency. Previous research at Kansas State University (Hightshoe et al., Cattleman's Day 1990, Report of Progress 592) demonstrated that incorporating rumen-escape lipid into a range supplement significantly improved postpartum reproductive characteristics. Our objective was to determine the optimum level of rumen-escape lipid to enhance calf weight gain, milk production, and return to estrus in beef heifers with their first calf.

Experimental Procedures

Fifty, spring calving, 2-yr old, beef heifers with an average initial weight of 825 lb and an average body condition score (BCS; 1 = emaciated, 9 = obese) of 4.8 were separated by weight, BCS, and calving date. These outcome groups (10 heifers/group) were assigned randomly to control or to receive .25, .5, 1, or 2 lb/d of rumen-escape lipid (REL; Megalac®, calcium salts of fatty acids). Rumen-escape lipid was fed in a milo and soybean meal-based supplement at various levels; all supplements provided equal levels of energy, crude protein, calcium, and phosphorus. The remainder of the diet consisted of coarsely ground native prairie hay. Total daily nutrient intake was formulated to meet NRC requirements for lactating first-calf beef heifers. Heifers were individually fed once daily beginning 14 d postpartum (PP), and weekly plasma samples were obtained. Estrus activity was monitored twice daily beginning 28 d PP to determine the interval from parturition to first observed standing estrus. Heifers were weighed and BCS was determined every 2 wk; calves were weighed every 4 wk. Approximately 70 d PP, each heifer and her calf were separated overnight. The following morning, heifers were milked mechanically, and daily milk production was determined.

[1]This research was supported in part by a grant from Church and Dwight Co., Princeton, NJ.

Results and Discussion

Results of the study are shown in Table 1. Heifers fed intermediate levels (.25, .5, or 1 lb) of REL generally produced more milk and supported greater calf gains while maintaining weight and BCS's similar to controls or heifers fed 2 lb REL daily. Though level of REL did not consistently affect heifer weight change ($P > .77$), there was a trend ($P = .12$) toward greater body condition loss as level of REL increased. Calves nursing heifers fed .25, .5, or 1 lb of REL daily gained more weight during the trial. This could be attributed to the trend ($P = .10$) for increased milk production by these heifers. Plasma cholesterol (CHOL) and triglycerides (TG) were similar ($P > .78$) among treatments (110.6 ± 6.9 and 17.4 ± 2.7 mg/dl, respectively) at the beginning of the trial but increased linearly as lipid intake increased ($P < .01$). Feeding higher levels of REL did not shorten the interval to observed standing estrus as expected. Rather, this interval tended ($P = .09$) to be slightly prolonged, with the most notable effect at the 2 lb level. Analysis of serum progesterone will be completed to assess interval to first ovulation and length of the subsequent luteal phase. In this study, REL fed at intermediate levels (.25, .5, or 1 lb/d) was effective in increasing milk production and calf weight gain. Moreover, plasma CHOL and TG were elevated in the heifers within 14 d of initiation of lipid feeding. Lipid feeding has been shown in other studies to enhance luteal function in the PP beef cow, but effects on shortening the PP interval remain unclear.

Table 1. Effect of Level of Rumen-Escape Lipid on Performance and Plasma Metabolites of Postpartum Crossbred Beef Heifers

	Rumen-Escape Lipid, lb/d						Response[1]		
Item	Control	.25	.5	1	2	SE	L	Q	C
Heifer wt change, lb	+22.3	–1.8	+22.5	+8.8	+11.7	12.1	.82	.77	.77
Heifer BCS change[2]	–.14	–.34	–.24	–.33	–.54	.17	.12	.96	.70
Calf wt gain, lb	83.8	101.2	91.5	91.1	80.9	4.9	.11	.11	.16
Milk production, lb/d	13.6	16.8	14.8	16.4	13.1	1.3	.41	.10	.85
CHOL, mg/dl (d 14 trial)[3]	112.8	142.9	154.9	161.0	177.8	7.7	.01	.02	.08
CHOL, mg/dl (d 28 trial)	128.6	165.7	176.0	209.1	244.0	11.0	.01	.08	.58
TG, mg/dl (d 14 trial)[4]	15.8	23.9	24.1	25.7	27.9	2.7	.01	.14	.22
TG, mg/dl (d 28 trial)	16.8	23.2	23.4	27.3	23.9	3.2	.20	.07	.78
Estrus interval[5]	77	85	80	82	91	5	.09	.80	.51

[1]L = linear, Q = quadratic, and C = cubic. Responses with associated ($P \leq$) values are given.
[2]BCS = body condition score (1 = emaciated; 9 = obese).
[3]CHOL = plasma cholesterol.
[4]TG = plasma triglycerides.
[5]Days from calving to first detected standing estrus.

PREGNANCY RATES IN BEEF CATTLE AFTER ADMINISTRATION OF GnRH AGONIST 11 TO 14 DAYS AFTER INSEMINATION

I. Rettmer, J. S. Stevenson, and L. R. Corah[1]

Summary

Pregnancy rates were assessed in suckled beef cows (n = 145) and virgin beef heifers (n = 606) of mixed breeding following an injection of either 100 or 200 µg of a GnRH agonist given once on d 11-14 after estrus and insemination. In heifers, the 100 µg dose improved (P < .08) pregnancy rates, based on rectal palpation of the uterus, and at both doses, based on actual calving dates. There was no effect of either dose on pregnancy rates of suckled cows, based on palpation results, but actual calving showed a 21% increase (P < .08) in pregnancy rates in cows treated with 100 µg of the GnRH agonist.

(Key Words: GnRH Agonist, Pregnancy Rates, Suckled Cows, Heifers.)

Introduction

Several studies have indicated improved pregnancy rates in cattle treated during the postinsemination period with various potent gonadotropin-releasing hormone (GnRH) agonists (analogs that mimic the biological effects of the parent compound). GnRH is a naturally occurring decapeptide (protein) composed of amino acids and produced by the hypothalamus in the brain. Hypothalamic GnRH causes the release of the gonadotropins, luteinizing hormone (LH) and follicle-stimulating hormone (FSH), from the pituitary gland. Currently, two GnRH products are on the market: Cystorelin® (gonadorelin diacetate tetrahydrate), available from SANOFI Animal Health Inc., Overland Park, KS (formally known as CEVA Laboratories, Inc.); and Factrel® (gonadorelin hydrochloride) produced by Fort Dodge Laboratories, Fort Dodge, IA. These two GnRH products are similar to the naturally occurring GnRH and have nearly equal potency.

Several new GnRH agonists (currently available for experimental use) are more potent (2.5 to 10 times) in their ability to release LH and FSH. One of these agonists is fertirelin acetate (marketed outside the U.S. as Ovalyse®), available from The Upjohn Company, Kalamazoo, MI.

The objectives of our study were to determine the dose-pregnancy rate effect of fertirelin acetate in a multi-location field study, utilizing both virgin heifers and suckled beef cows.

[1]We acknowledge the assistance of the following cattle producers who most willingly cooperated in this study conducted in the spring and summer of 1989: Gerald (Corky) Albright, Delia, KS; Henry Gardiner, Ashland, KS; Gary Johnson, Dwight, KS; Dr. Rodney Oliphant, Offerle, KS; Ken Stielow, Paradise, KS; and Joe Thielen, Dorrance, KS. We also thank Dr. John Chenault of The Upjohn Company for donating the Lutalyse and fertirelin acetate used in this field trial. This study was carried out under Investigational New Drug Authorization (INADA) 2996.

Experimental Procedures

Suckled cows (n = 162) at two locations and virgin heifers (n = 606) at five locations were inseminated at a synchronized estrus. Estrus was synchronized in heifers by feeding .5 mg melengestrol acetate (MGA) for 14 d and then injecting (i.m.) 25 mg Lutalyse® 17 d after the last daily feeding of MGA. Suckled cows were given one injection (i.m.) of Lutalyse to regress the corpus luteum and induce estrus in those cows that were cycling. Cows and heifers were inseminated 6-12 h after estrus was observed. Cows were of mixed breeding across locations, including purebred and crosses of Angus, Hereford, Simmental, and Salers.

Once heifers and cows were inseminated, they were allotted, based on inseminator and sire of breeding, into blocks and assigned randomly to receive (i.v.) either 100 or 200 µg of a GnRH analog agonist (fertirelin acetate in 4 ml of saline) or a control dose of 4 ml saline. Injections of the GnRH agonist were given once on d 11-14 after estrus (d 0 = estrus). Heifers and cows were exposed to clean-up bulls or re-inseminated after the initial artificial insemination and subsequent treatment. Pregnancy was verified by palpation of the uterus per rectum between 45 and 80 d after insemination and(or) by actual calving dates at two of five locations of heifers and at both locations of cows. Blood was collected from all females at treatment. Those with concentrations of progesterone in serum < 1 ng/ml were excluded from analyses, because we assumed that they were not in their luteal phase at the time of GnRH treatment.

Results and Discussion

Results for heifers at five locations are summarized in Table 1. There appeared to be a pregnancy rate response to the agonist in heifers at four of the locations (locations 1, 2, 4, and 5), based on palpation results. Based on actual calving dates at two locations, both doses of the GnRH agonist appeared to increase pregnancy rates. The 100 µg dose increased ($P < .08$) pregnancy rates beyond that of the control. However, based on fewer actual calvings, the effect of the GnRH agonist at both doses tended ($P < .11$) to improve fertility.

Results of the experiment for suckled cows at two locations are summarized in Table 2. There was no effect of either dose, based on the palpation results, but 100 µg of the GnRH agonist increased ($P < .08$) pregnancy rates, based on calving.

The difference in the results between pregnancy rates by palpation and those obtained by actual calvings can be accounted for by the difficulty in differentiating ages of fetuses that were 15 to 20 d apart. This difficulty mainly occurred when palpations were performed at d 70 to 80 after insemination, particularly at one location of heifers and at one location of cows, when differentiating between fetuses of 70-80 days of age and those of 50-60 days of age.

These results provide good preliminary evidence and that administering a GnRH agonist to virgin heifers and suckled cows during the luteal phase (d 11 to 14) after insemination increases pregnancy rates. Other work indicates that the mode of action is the ability of the GnRH agonist to luteinize ovarian follicles or in some way alter follicular function at this stage of the estrous cycle or pregnancy, thereby rendering follicles non-estrogenic and delaying the luteolytic process for several days, sufficient to increase the probability of pregnancy in some females.

Table 1. Pregnancy Rates (%) in Virgin Beef Heifers Based on Palpation of the Uterus (45 to 80 d) and Actual Calving Dates[1]

	Location					
Dose, µg	1	2	3	4	5	Total
			Pregnancy Rates - Palpation Data			
0	35/68	14/29	14/28	3/20	20/56	86/201
	(51.5)	(48.3)	(50.0)	(15.0)	(35.7)	(42.8)
100	33/66	17/27	12/25	13/21	25/58	100/197
	(50.0)	(63.0)	(48.0)	(61.9)	(43.1)	(50.8)[a]
200	41/67	18/30	14/27	9/23	18/56	100/203
	(61.2)	(60.0)	(51.9)	(39.1)	(32.2)	(49.3)
			Pregnancy Rates - Calving Data			
0		13/29		11/19		24/48
		(44.8)		(57.9)		(50.0)
100		18/27		13/20		31/47
		(66.7)		(65.0)		(66.0)[b]
200		19/30		15/22		34/52
		(63.3)		(68.2)		(65.4)[b]

[1]Injection of fertirelin acetate was given (i.m.) once on d 11-14 after estrus (d 0) and insemination.
[a]Different (P < .08) from control (0 µg) dose.
[b]Different (P = .11) from control (0 µg) dose.

Table 2. Pregnancy Rates (%) in Suckled Beef Cows Based on Palpation of the Uterus (45 to 80 d) and Actual Calving Dates[1]

	Location		
Dose, µg	1	2	Total
		Pregnancy Rates - Palpation Data	
0	21/29	15/22	36/51
	(72.4)	(68.2)	(70.6)
100	17/21	13/22	30/43
	(81.0)	(59.0)	(69.8)
200	20/25	14/26	34/51
	(80.0)	(53.8)	(66.7)
		Pregnancy Rates - Calving Data	
0	20/27	10/14	30/41
	(74.1)	(71.4)	(73.2)
100	18/21	14/15	32/36
	(85.7)	(93.3)	(88.9)[a]
200	17/22	14/16	31/38
	(77.3)	(87.5)	(81.6)

[1]Injection of fertirelin acetate was given (i.m.) once on d 11-14 after estrus (d 0) and insemination.
[a]Different (P = .08) from control (0 µg) dose.

FOLLICULAR DEVELOPMENT AND REPRODUCTIVE HORMONE CHANGES DURING POSTPARTUM ANESTRUS IN SUCKLED BEEF COWS[1]

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Summary

Twenty-six, Hereford × Angus, suckled cows were utilized to determine patterns of follicular development and associated changes in reproductive hormones during postpartum anestrus and first estrous cycles. Ultrasonography per rectum was used to monitor follicular size and detect ovulation. Dietary energy and(or) body condition influenced patterns of follicular development during postpartum anestrus. Follicular growth occurred in waves during this period in cows that were in adequate body condition and adequately fed, and follicular development appeared to be related to serum concentrations of luteinizing hormone and estradiol. Two distinct characteristics were associated with follicular development before the first postpartum ovulation. First, diameter of dominant follicles increased with successive follicular waves. Second, a large dominant follicle was present for an extended time before development of the first ovulatory follicle and appeared to be involved in the mechanism that initiates the first ovulation after calving.

(Key Words: Cattle, Postpartum, Ovarian Follicles, Ultrasonography.)

Introduction

Duration of postpartum anestrus determines when and if cows rebreed following calving, both of which heavily influence the profitability of beef cow/calf production. However, in terms of reproductive management, this period still presents problems for many producers. A better understanding of the events and mechanisms responsible for initiating the return to cyclicity after calving is needed before recommendations or programs can de developed that will help beef producers better manage this economically important period. Our objectives were to determine the patterns of follicular growth and relate those patterns to changes in reproductive hormone from calving to the first postpartum ovulation in suckled beef cows.

Experimental Procedures

Twenty-six Hereford x Angus cows were utilized to study the effects of pre- and postpartum levels of dietary energy on postpartum reproductive performance. A 2×2 factorial arrangement of treatments was used with cows receiving either 70 (L) or 150% (H) of the NRC recommended level of dietary energy either before and(or) after calving, resulting in four treatment combinations (L-L, L-H, H-L, H-H). Ultrasonography per rectum was used to monitor follicular size and detect ovulation. Ovarian scans were performed at 2-d

[1]Authors are grateful to S. Henderson-Perry, R. Hightshoe, T. Ridder, B. Fox, and K. Johnson for assistance with data collection.
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intervals starting at 6 d postpartum, then daily from 25 d postpartum until 10 d after the second postpartum ovulation or until 150 d postpartum.

Patterns of follicular growth were classified according to the occurrence of follicular waves. A wave of follicular growth was defined as the synchronous development of a group of follicles that were first detected within 3 d of each other. Follicles were classified as dominant if they reached a diameter of ≥ 8 mm and exceeded the diameter of all other follicles within the follicular wave. Subordinate follicles were those that appeared to originate from the same follicular group as the dominant follicle and decreased in size within a few days after detection. Follicular growth was classified as wave-like only if all dominant follicles were first detected in association with one or more subordinate follicles.

Jugular blood samples were collected at 2-d intervals from calving until 24 d postpartum, then daily from 25 d postpartum until the end of the study. Serum samples were assayed to determine concentrations of progesterone and estradiol. On d 14, 42, and 70 postpartum, blood was collected every 15 min for 6 h via indwelling jugular catheters and assayed for concentrations of luteinizing hormone.

Results and Discussion

Thirteen (five L-H, two H-L, and six H-H cows) of 26 cows ovulated by 150 days postpartum. Two very distinct characteristics of follicular development appeared in all cows that ovulated. First, all cows exhibited increases in the diameter of dominant follicles of successive follicular waves as days postpartum increased. Secondly, a large dominant follicle was present for an extended time before development of the first preovulatory follicle. This follicle was detected longer and was larger in maximal diameter than other follicles detected before ovulation and appeared to be a result of or part of the mechanism that initiates cyclicity in suckled beef cows.

All cows in the H-H group ovulated after exhibiting wave-like follicular growth. Thus, it appeared that follicular growth occurred in waves during postpartum anestrus if cows were in adequate body condition and were receiving adequate nutrition. In the 13 cows that ovulated, regardless of treatment group, diameter of the largest follicle increased with successive follicular waves, as indicated by the correlation ($r = .50$, $P < .0001$) between diameter of the largest follicle and day postpartum. Follicular growth in one representative cow that ovulated is depicted in Figure 1.

All cows that ovulated had increases in serum estradiol preceding the first and second postpartum ovulations. Estradiol concentrations were correlated positively ($r = .20$, $P < .0001$) with diameter of the largest follicle and numbers of large (≥ 10 mm) follicles. However, serum estradiol did not appear to change in relation to the development of the last, dominant, non-ovulatory follicle.

Three of six cows in the L-H treatment group exhibited waves of follicular growth from parturition to the first postpartum ovulation. In the other three cows of this treatment group, a majority of follicular growth occurred in waves. However, the appearance of follicular waves was interrupted by large follicles that were not associated with any subordinate follicles. A majority of the follicular growth occurred in waves for all cows in the H-L treatment group.

None of the cows in the L-L group ovulated during the study, but two distinct patterns of follicular growth were detected. Three cows had patterns of follicular growth that were characterized as being partially wave-like. Four had no detectable waves of follicular growth and were classified as being random or continuous in nature. Few of the large follicles in cows in the L-L group were classified as dominant because they were not detected with a group of subordinate follicles. However, the pattern of growth of the large follicles in cows with partial wave-like follicular growth was similar to the growth and regression of dominant follicles in cows exhibiting waves of follicular growth.

Cows with partial wave-like follicular growth had detectable follicles much earlier postpartum and shorter intervals from calving to detection of a follicle $\geq$ 8 mm in diameter than the four cows with no follicular waves in the L-L group. It appeared that the partial wave-like follicular growth in L-L cows was due to a lack of subordinate follicles and not to a difference in the growth pattern of large follicles. The lack of subordinate follicles was probably a result of the nutritional treatments and possibly mediated through secretion of luteinizing hormone, because no cows in this treatment group exhibited pulses of luteinizing hormone at any of the sampling times. The other cows in the L-L treatment group with random patterns of follicular growth, exhibited more follicular development later after parturition, even though they were losing weight and body condition at that time. Thus, despite their poor body condition, they may have escaped some inhibitory effect or received some stimulatory influence later in the postpartum period.

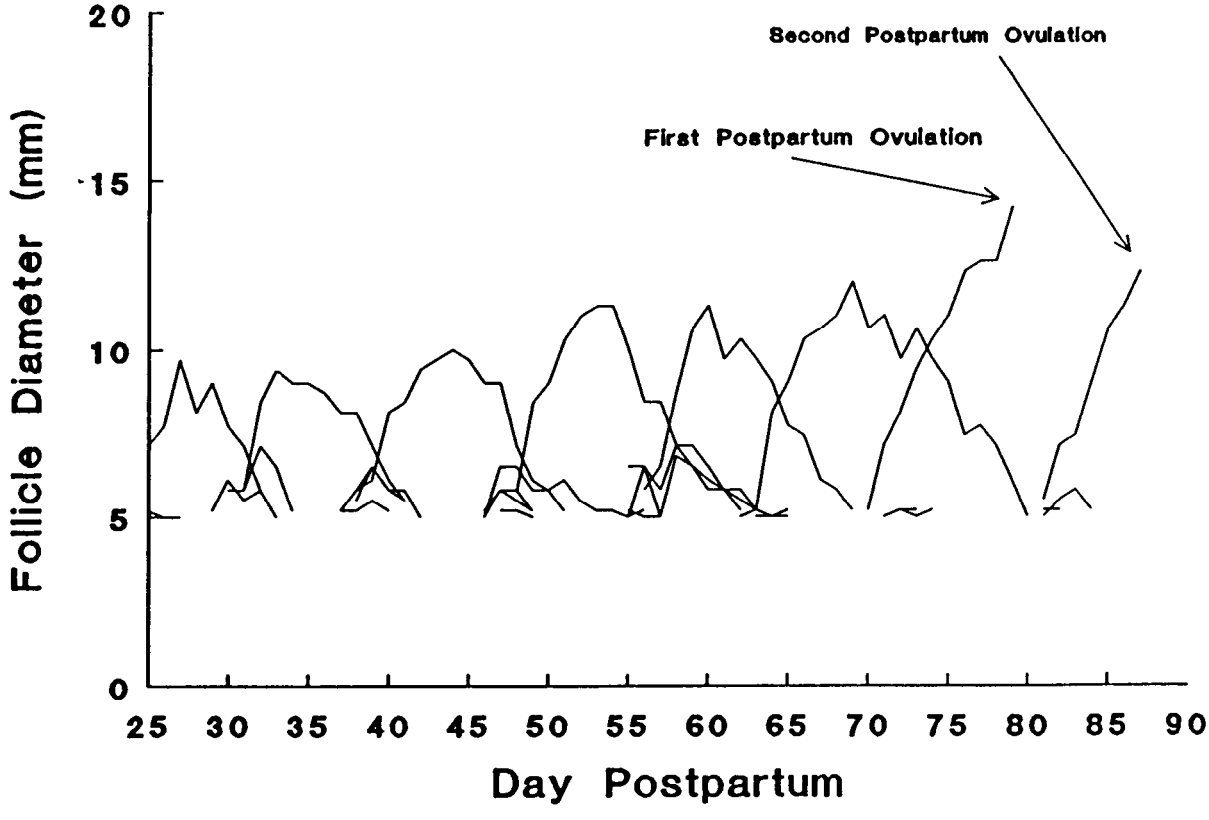

Figure 1. Waves of Follicular Growth from 25 Days Postpartum through the Second Postpartum Ovulation (Each Line Represents an Individual Follicle)

SEASONAL PERFORMANCE OF FINISHING STEERS

T. Schroeder[1], J. Mintert[1], and M. Langemeier[1]

Summary

Analysis of 10 years of closeouts from a western Kansas feedlot demonstrated that steer performance exhibits significant seasonal variation. Steers weighing 700 to 800 lb when placed on feed in September through December had feed conversions roughly 12% higher than those placed in March and April. Although feed conversion varied seasonally, dry matter feed intake varied much less, causing daily gain to mirror feed conversion. Gain was seasonally highest for steers placed in March and April and lowest for those placed in September through December. Cattle feeders should consider these variations in seasonal performance, as they develop profit projections for steers being placed on feed.

(Keywords: Feeding Performance, Seasonality, Steers.)

Introduction

Cattle performance in a feedlot has a profound impact on profitability. For example, a 5% increase in dry matter feed/gain conversion from 6.2 to 6.5 can result in more than a $10/head increase in feed costs alone for finishing yearling steers (using October 1990 dry matter feed costs of $.078/lb extracted from feedlot closeout summaries reported by Kuhl, KSU Focus on Feedlots newsletter, November 1990). When developing projected budgets, cattle feeders need to consider factors that may alter performance. Weather is one primary factor beyond the control of feedlots that needs to be considered. Fluctuations in weather lead to seasonal fluctuations in cattle performance that exceed 5% and may approach 15% from one extreme to the other. This study documents the seasonal variation in feedlot performance associated with finishing yearling steers.

Experimental Procedures

Monthly closeouts of steers placed on feed from 1980 through 1989 were collected from a feedlot in western Kansas. Seasonal patterns of feed conversion, daily gain, feed intake, and death loss were evaluated based on 1223 lots representing over 250,000 head of 700 to 800 lb steers. Feed conversions were collected on an as-fed basis and converted to a dry matter basis by adjusting the monthly figures to levels that yielded an average annual dry matter feed conversion of 6.4. This adjustment did not change the relationship between monthly feed conversions.

Results and Discussion

Table 1 presents the monthly averages and standard deviations for dry matter feed conversion, gain, dry matter feed intake, and death loss. Feed conversion exhibited a significant seasonal pattern (Figure 1). Steers weighing 700 to 800 lb placed on feed during the September through December period had average feed conversions of approximately 6.8, which were over 12% higher than feed conversions for similar steers placed on feed in March and April. Variation in feed conversion over time and across pens also differed by season. Steers placed on feed in September through December averaged 45% greater

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variation (plus or minus) in feed conversion than those placed in March and April. This indicates that departures from normal feed conversions can be expected to be 45% greater for steers placed on feed in September through December than for steers placed in March and April.

Daily gain also exhibited a significant seasonal pattern (Figure 2). Steers placed on feed in September through December had gains of roughly 2.90 lb. In contrast, steers placed in March and April had 12% higher gains (3.24 lb). Variation in gain was highest for steers placed on feed in December and lowest for steers placed in May.

Although gain and feed conversion varied seasonally, average dry matter feed intake was relatively constant over the year (Table 1). Average daily dry matter feed intake over the entire feeding period ranged from a high of 19.77 lb for steers placed in January to a low of 18.77 for those placed in May. This indicates that much of the seasonal variation in gain is attributed to variation in feed conversion. That is, because the cattle are consuming essentially the same amount of feed over the entire feeding period, regardless of placement month, variations in gains are a result of differing feed conversions. This conjecture is reinforced by the approximate mirror images exhibited in the seasonal patterns of feed conversion and gain (Figures 1 and 2).

Death loss also varied seasonally (Table 1). The highest death losses were noted for steers placed in November (0.72%), and lowest death losses occurred for those placed in March (0.35%).

Table 1. Averages and Standard Deviations of Selected Feeding Performance Measures by Month Placed on Feed for 700 to 800 lb Steers, 1980-89

Month placed	Feed Conversion[1]		Daily Gain[2]		Feed Intake[3]		Death Loss[4]	
On Feed	Avg	SD[5]	Avg	SD[5]	Avg	SD[5]	Avg	SD[5]
January	6.38	0.63	3.12	0.30	19.77	1.19	0.49	0.75
February	6.26	0.49	3.19	0.27	19.91	1.28	0.49	0.69
March	6.04	0.37	3.26	0.26	19.60	1.06	0.35	0.55
April	6.06	0.37	3.22	0.25	19.46	1.04	0.43	0.65
May	6.08	0.39	3.10	0.22	18.77	1.02	0.46	0.73
June	6.16	0.38	3.16	0.25	19.36	0.88	0.47	0.57
July	6.20	0.35	3.21	0.29	19.81	1.24	0.46	0.56
August	6.42	0.45	3.09	0.26	19.71	1.01	0.42	0.56
September	6.78	0.55	2.91	0.28	19.59	0.93	0.61	0.67
October	6.79	0.50	2.90	0.26	19.59	1.13	0.55	0.78
November	6.89	0.52	2.87	0.28	19.65	1.29	0.72	0.97
December	6.79	0.59	2.91	0.35	19.64	1.47	0.58	0.85

[1]Feed/gain, dry matter basis.
[2]Lb per head daily.
[3]Lb dry matter per head daily.
[4]Percent.
[5]Standard deviation.

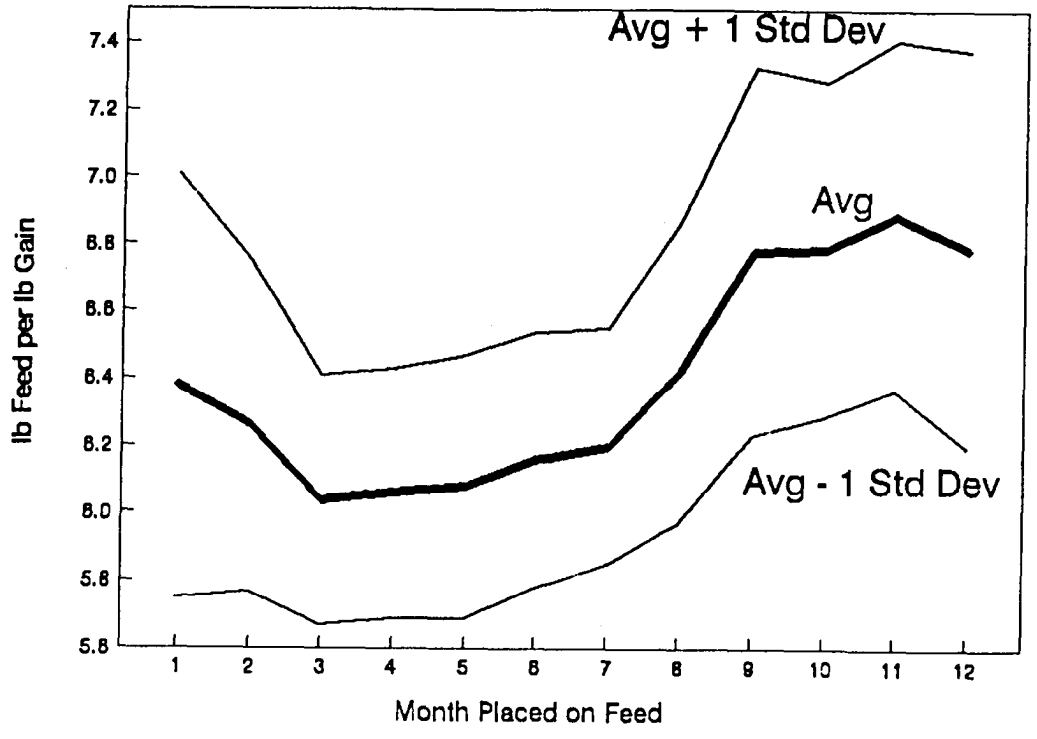

Figure 1. Average Feed Conversion by Month Placed on Feed for 700 to 800 lb Steers

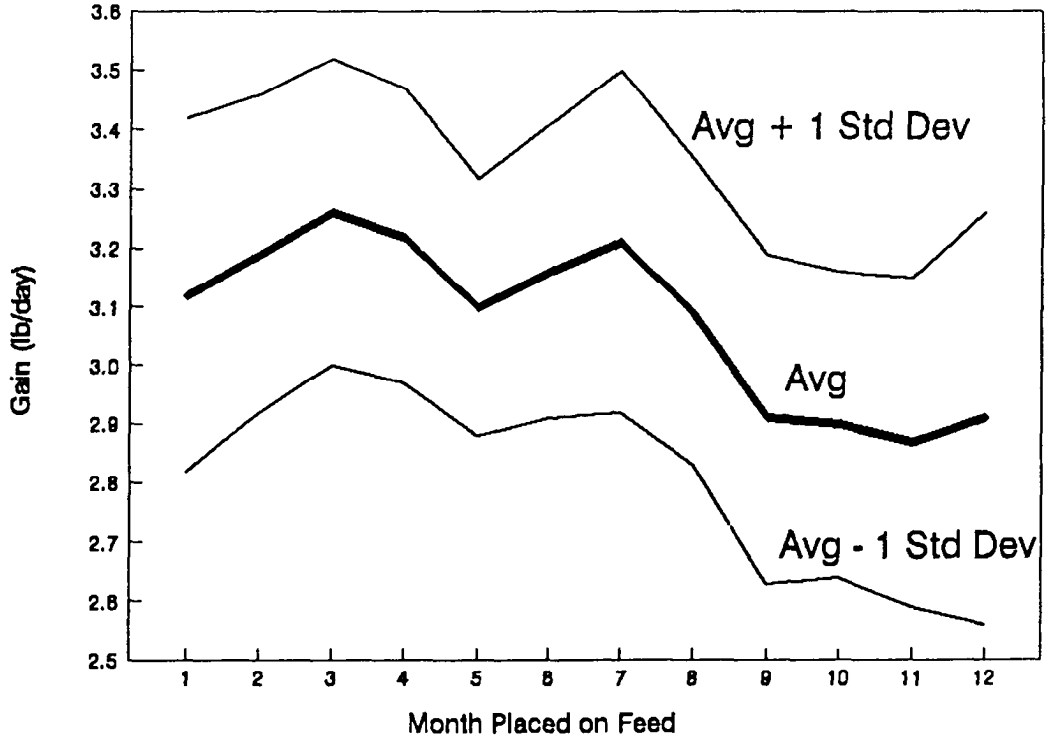

Figure 2. Average Daily Gain by Month Placed on Feed for 700 to 800 lb Steers

SEASONAL PERFORMANCE OF FINISHING HEIFERS

M. Langemeier[1], T. Schroeder[1], and J. Mintert[1]

Summary

This study examined the impact of date of feedlot placement on feed conversion, daily gain, and death loss. Results indicated that heifers placed on feed from September to December required more feed per pound of gain, had lower daily gains and higher death loss, and generally exhibited more variation in feeding performance than heifers placed during the rest of the year. Cattle feeders should take these performance variations into account when developing budgets and calculating breakeven sale prices for heifers.

(Key Words: Feeding Performance, Seasonality, Heifers.)

Introduction

Many cattle feeders and industry analysts develop budgets and calculate breakeven prices on a monthly basis to determine the potential profitability of finishing cattle. These budgets require information pertaining to feeder and ration prices and cattle performance. Reasonable estimates of feeder and ration costs are fairly easy to obtain. Cattle performance, on the other hand, is difficult to ascertain. This study used fed cattle closeouts from a western Kansas feedlot to determine the impact of placement date on feed conversion, average daily gain, and death loss of heifers.

Procedures

Feedlot performance information was obtained from a western Kansas feedlot's monthly closeouts covering 704 pens of heifers (132,899 head) placed on feed during the 10-year period from 1980 to 1989. Specifically, feed conversion, daily gain, and death loss were obtained for heifers with an initial weight between 600 and 700 lb. Feed conversions were reported on an as-fed basis on the close-outs. Information relating to the actual composition and dry matter content of the rations fed was not available. Thus, feed conversions were converted to a dry matter basis by adjusting monthly feed conversions to levels that yielded an annual average feed conversion of 6.5 lb. This procedure did not change the relationship between monthly feed conversions.

Results and Discussion

Table 1 presents the averages and standard deviations of feed conversion, daily gain, dry matter feed intake, and death loss for heifers placed during the 1980-1989 period. Feed conversions on a dry matter basis exhibited a seasonal pattern (Figure 1) and were about 10% higher for heifers placed from September through December. In addition, heifers placed on feed in September through December had an average 37% greater variation in feed conversion than those placed during the rest of the year. This indicates that departures from expected feed conversion will be about 37% higher for heifers placed during the last 4 months of the year.

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Figure 2 depicts daily gains by placement month for 600 to 700 lb heifers. A distinct seasonal pattern was evident. Average daily gains were about 8% lower for heifers placed in September through December than for those placed in the rest of the year. Variation in daily gain was about 29% higher for heifers placed in September through December.

In contrast to feed conversion and daily gain, feed intake was relatively constant throughout the year. Daily feed intake ranged from a low of 17.49 lb in May to a high of 18.51 lb in December. The relative stability of feed intake implies that feed conversion and average daily gain move in opposite directions by about the same magnitude across months.

Death loss also tended to vary with the month in which heifers were placed. Death losses were higher than normal for heifers placed in September, October, and November. The highest death loss was for heifers placed in November (1.86%).

Table 1. Average and Standard Deviations of Selected Feeding Performance Measures by Month Placed on Feed for 600 to 700 Lb Heifers, 1980-1989

Month Placed On Feed	Feed Conversion[1]		Daily Gain[2]		Feed Intake[3]		Death Loss[4]	
	Avg	SD[5]	Avg	SD[5]	Avg	SD[5]	Avg	SD[5]
January	6.25	0.43	2.86	0.25	17.88	1.02	0.81	0.66
February	6.26	0.28	2.83	0.17	17.72	0.82	0.79	0.84
March	6.25	0.41	2.91	0.25	18.19	1.01	0.69	1.59
April	6.28	0.35	2.87	0.18	18.02	0.97	0.79	1.60
May	6.36	0.41	2.75	0.23	17.49	1.11	0.84	0.90
June	6.30	0.40	2.78	0.22	17.51	1.29	0.77	0.78
July	6.16	0.34	2.93	0.22	18.05	0.88	0.84	1.28
August	6.41	0.37	2.83	0.24	18.14	0.83	0.72	1.13
September	6.75	0.52	2.63	0.29	17.75	1.12	1.50	1.42
October	6.93	0.58	2.58	0.31	17.88	1.11	0.98	1.22
November	7.10	0.66	2.55	0.31	18.11	1.38	1.86	2.58
December	6.96	0.58	2.66	0.31	18.51	1.24	0.61	0.79

[1]Feed/gain, dry matter basis.

[2]Lb per head daily.

[3]Lb dry matter per head daily.

[4]Percent.

[5]Standard deviation around the mean.

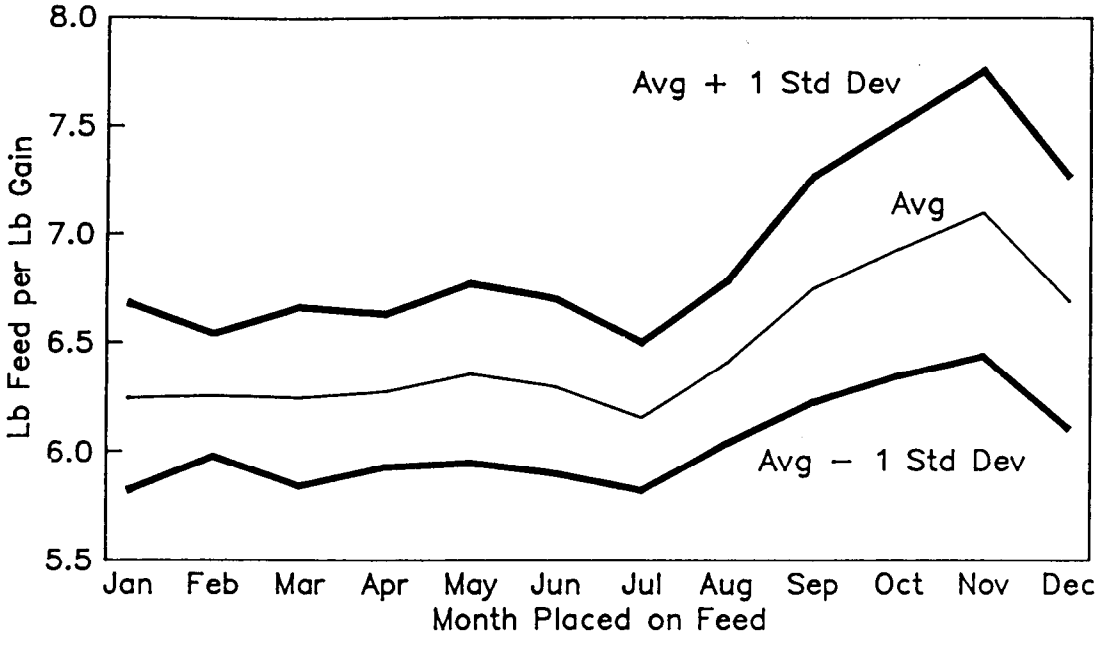

Figure 1. Average Feed Conversion by Month Placed on Feed for 600 to 700 lb Heifers

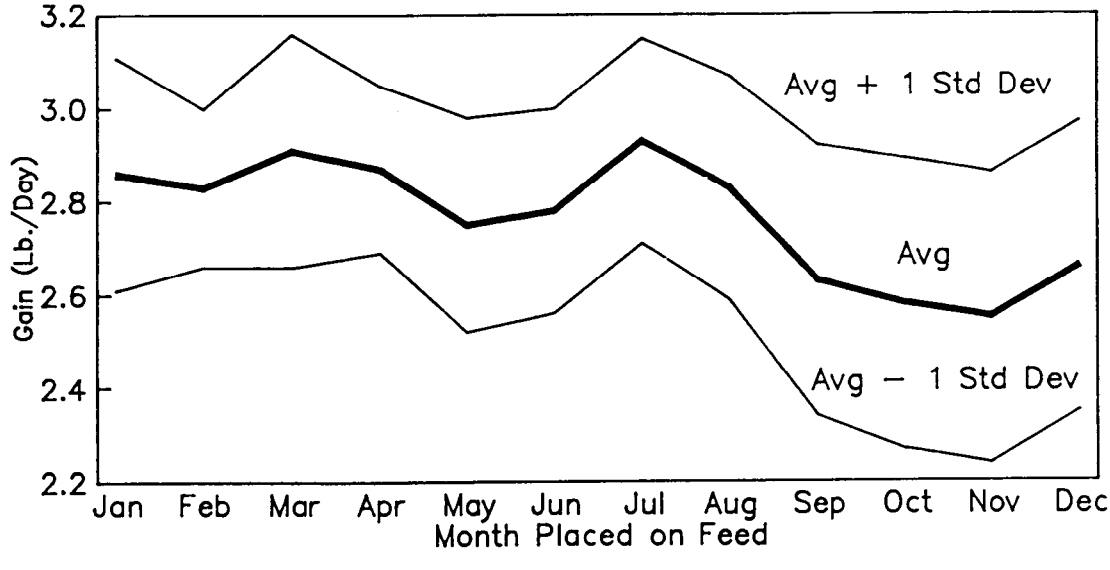

Figure 2. Average Daily Gain by Month Placed on Feed for 600 to 700 lb Heifers

KANSAS STEER FUTURITIES: AN ECONOMIC ANALYSIS OF RETAINED OWNERSHIP AND A SUMMARY OF CATTLE PERFORMANCE FROM 1974-1988

D. Simms, J. Mintert[1], and A. Maddux[2]

Summary

The performance, carcass characteristics, and economic data from over 6,200 steers entered in Kansas Steer Futurities from 1974 through 1988 were summarized to evaluate production trends and profitability. The steers' delivery weights, final weights, and frame scores increased over the 14-year period, while daily gain was essentially unchanged. The quality grade, fat thickness, and yield grade all decreased slightly. Ribeye area increased slightly, but ribeye area per unit of carcass remained constant over the years.

Based on the delivery weight of the steers, price, normal production relationships, and estimated production costs, we estimate that net returns over cash costs for the cow/calf phase have averaged $5.97 per cow unit from 1974 through 1988, with losses in 7 of those years. Correspondingly, steers in the futurities have been profitable in 10 of the 14 years, with an estimated average return of $38.43. Thus, retaining ownership should be a viable marketing alternative for progressive Kansas cattle producers.

(Key Words: Futurity, Retained Ownership, Marketing.)

Introduction

The Kansas Steer Futurity program was developed in 1974 to provide producers with performance and carcass information on their cattle. The economic results were provided as secondary information; however, it soon became obvious that accelerated feeding had significant profit potential. The original analysis of the futurities' performance and economic data was conducted by Lambert and co-workers in 1984 (Cattlemen's Day Rep. of Progress 448). The current summary was conducted to update this information and determine if earlier trends in performance, carcass characteristics, and returns had persisted.

Experimental Procedures

Although procedures at the 70 futurities involving over 6,200 cattle in 14 locations were not totally standardized, in general, lots of five spring born calves were delivered to the feedlot in late November or early December. After a warm-up period of approximately 21 days, the calves were placed on the final finishing ration until slaughter in May or early June. In most futurities, the calves were all fed in one pen.

The cattle were slaughtered in groups either when they reached 0.4 in. of backfat, when they approached 1400 lb, or when it was time to close out the pen. Thus, although 0.4 in. of fat was the goal, some cattle were slaughtered based on other practical considerations.

The economic analysis from 1974-1983 was taken from the work of Lambert and co-workers (1984 Cattlemen's Day) with slight modification. The costs for the cow/calf phase were based on data from the Kansas Farm Management Association and costs for the feedlot phase were based on actual costs

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incurred in the futurities. Market value of the calves at delivery was based on Kansas City market quotes for the delivery months.

For the analysis of breed type and frame score, individual feed consumption was based on National Research Council formulas for feed intake, which take into account average body weight maintained and rate of gain. For that part of the analysis, average prices and costs for the period of 1983-1988 were used, which resulted in higher profit levels than were obtained over the entire 14-year period.

For the analysis by breed, the cattle were grouped according to the U.S. Meat Animal Research Center classification as follows:

Large Continentals (LC) - Beef Fresian, Charolais, Chianina, Maine Anjou, and Simmental
Medium Continentals (MC) - Gelbvieh, Blonde D'Aquitaine, and Beef Brown Swiss
Small Continentals (SC) - Limousin, Pinzgauer, Salers, South Devon, and Tarentaise
British - Angus, Red Angus, Hereford, Polled Hereford, and Shorthorn

Additionally, cattle with Brahman breeding, which included Santa Gertrudis, Brangus, Beefmaster, and Brahman crosses, were grouped together. Longhorn crosses also were considered a separate category. To make breed and frame score comparisons, differences related to test location and year were eliminated statistically.

Results

Performance of the steers by year is shown in Table 1, and the carcass characteristics are shown in Table 2. Over the 14 years of the futurities, arrival weight, final weight and frame score increased, while daily gain was essentially unchanged. Fat thickness at slaughter tended to decrease, which lowered numerical yield grades and quality grades slightly. Ribeye area increased but not when expressed on a per unit carcass weight basis.

Table 3 shows the economic data for the cow/calf phase from 1974-1988, indicating that this phase was profitable in only 7 of the 14 years, with an average return of $5.97 per head. Furthermore, returns were extremely variable, with a low of $–106.79 and a high of $115.80 per head. Table 4 shows the economic analysis for the feedlot phase during this same period, indicating that this phase was profitable in all but 4 years, with an average return of $44.43. Finishing returns also exhibited a great deal of variability over the 14 years.

The performance by breed type is shown in Table 5. The most profitable breed groups were those that combined high growth rate with the ability to reach the choice grade at fat thicknesses of 0.4 in. or less.

The performance by frame score group is shown in Table 6. Starting weight and carcass weight increased with frame score, whereas average daily gain plateaued at frame score 6. Fat thickness, quality grade, and yield grade decreased as frame score increased. Profitability increased up to frame score 3 and then leveled off. Thus, a wide range of cattle types was equally profitable under the accelerated feeding program used in the futurities.

Table 1. Performance of Futurity Steers by Year

Year	No. head	On weight lb	Final weight lb	Start age, d	Final age, d	Frame score	Daily gain, lb	Wt/d age, lb	Days on feed
1974-75	448	524	1036	271	438	2.0	3.10	2.38	167
1975-76	477	522	1082	281	441	2.5	3.32	2.48	159
1976-77	513	587	1109	281	446	3.0	3.17	2.51	166
1977-78	545	619	1124	284	460	2.6	2.93	2.46	176
1978-79	554	631	1145	286	463	2.6	2.95	2.53	177
1979-80	533	616	1124	281	456	3.1	2.95	2.46	174
1980-81	551	617	1139	283	451	3.4	3.12	2.55	170
1981-82	599	671	1172	296	444	3.9	3.32	2.66	152
1982-83	583	662	1157	279	445	3.4	3.01	2.60	166
1983-84	587	647	1159	288	457	4.2	3.10	2.53	166
1984-85	647	666	1182	288	462	4.9	3.01	2.51	171
1985-86	657	675	1197	287	454	5.1	3.19	2.62	165
1986-87	644	622	1141	280	441	4.3	3.04	2.57	159
1987-88	668	704	1215	297	450	4.9	3.48	2.68	150

Table 2. Carcass Characteristics of Futurity Steers by Year

Year	Carcass wt, lb	USDA quality grade[1]	Yield grade	Fat thickness, in	Ribeye area, in^2	% Retail product	Ribeye area/ cwt carcasswt, in^2
1974-75	639	6.9	2.6	.41	11.9	71.1	1.87
1975-76	675	6.8	2.5	.41	13.0	71.7	1.93
1976-77	678	6.8	2.4	.34	12.1	71.9	1.80
1977-78	695	6.3	2.5	.35	13.0	71.5	1.88
1978-79	686	6.2	2.3	.35	12.2	72.4	1.77
1979-80	686	6.5	2.6	.34	12.6	71.2	1.84
1980-81	707	6.6	2.4	.35	12.4	72.0	1.76
1981-82	694	6.3	2.6	.33	12.7	71.3	1.84
1982-83	694	6.5	2.3	.33	12.7	72.3	1.84
1983-84	691	6.1	2.3	.35	12.8	72.5	1.85
1984-85	712	6.6	2.1	.32	13.3	73.3	1.87
1985-86	723	6.2	2.1	.33	13.8	73.3	1.91
1986-87	682	6.5	1.9	.27	12.8	74.0	1.88
1987-88	730	6.3	2.0	.30	13.6	73.9	1.86

[1]6.0 = Select +, 7.0 = Choice –.

Table 3. Economic Data of Cow/Calf Phase during 14 Annual Futurities

Year	Weight at delivery, lb	Price cwt at delivery	Calf value at delivery	Estimated[a] annual cash costs of cow ownership	Est. returns[b] from cows if calves sold at delivery	On-farm[c] weaning costs	Net calf returns
1974-75	523	$27.73	$145.15	$221.67	$124.10	$9.22	$–106.79
1975-76	551	37.73	206.67	223.96	168.32	8.15	–63.80
1976-77	582	37.27	217.87	228.85	176.93	8.40	–60.32
1977-78	589	40.91	241.20	221.52	201.20	8.35	–28.67
1978-79	589	69.55	409.76	244.21	342.35	9.15	88.99
1979-80	572	88.18	505.27	296.07	416.57	10.45	110.05
1980-81	575	77.27	444.33	348.93	370.70	14.12	7.05
1981-82	604	64.55	389.32	345.27	327.04	12.43	–30.76
1982-83	597	65.00	387.80	345.31	321.58	13.22	–36.95
1983-84	587	62.74	368.28	331.86	306.39	10.98	-36.45
1984-85	647	65.10	421.20	320.33	347.83	9.95	17.55
1985-86	657	62.70	411.94	287.85	342.16	8.48	45.83
1986-87	644	64.20	413.45	279.39	348.83	7.45	61.99
1987-88	668	79.50	531.06	326.18	450.02	8.04	115.80
14-yr avg			$363.81	$287.24	$303.14	$9.89	$5.97

[a]Based on average costs from Kansas Farm Management Association records. Feed costs were calculated at market rates with pasture charged at typical rental rates. Interest charges assumed 60 percent debt on operating expenses and livestock. Interest on breeding stock was calculated on the estimated cow's value + 16 percent of replacement heifer value + 4 percent of estimated bull value. Costs did not include a change for operator labor, depreciation on buildings and equipment, or a return on the 40 percent investment equity.

[b]Returns were based on a 92 percent calf crop. Therefore, sales included 46 percent of a steer calf; 30 percent of a heifer calf (16 percent held for replacement), cull cow sales of 14 percent per year, and a 2 percent death loss.

[c]Costs for on-farm weaning expenses calculated as one-half the average daily feedlot cost of cattle on feed for 14 days.

Table 4. Economic Data of Feedlot Phase during 14 Annual Futurities

Year	Interest[a] rate	Interest cost on feeder (180 days)	Total feedlot costs	Value of[b] steer at slaughter	Return[c] from feeding	Lifetime Returns
1974-75	6.5%	$4.83	$242.42	$525.75	$138.18	$31.39
1975-76	8.0	8.88	224.44	432.35	1.25	–62.55
1976-77	8.8	9.72	217.88	450.15	14.40	–45.92
1977-78	8.9	11.29	224.50	591.58	125.88	97.21
1978-79	10.1	21.77	246.11	753.74	97.87	186.86
1979-80	14.7	39.00	278.08	710.96	–72.40	37.65
1980-81	16.6	37.18	358.04	737.80	–64.57	–57.52
1981-82	17.2	31.00	286.33	808.95	133.30	102.54
1982-83	14.3	27.35	328.94	739.24	22.50	–14.45
1983-84	14.3	26.31	348.31	728.57	11.98	–24.47
1984-85	13.5	28.37	323.12	671.01	–73.31	–55.76
1985-86	12.4	25.60	261.25	645.21	–27.98	17.85
1986-87	11.4	23.57	211.65	772.71	147.61	209.60
1987-88	11.5	30.59	242.99	857.85	83.80	199.10
Average	12.0	$23.25	$271.00	$673.28	$38.43	$44.40

[a]From Federal Reserve Bank of Kansas City, average interest rates on feeder calf loans, first two quarters of each year, Kansas City area.
[b]Return at slaughter = Carcass price × Carcass weight, adjusted for death loss (average 1.26%).
[c]Return from feeding = Value at Slaughter – Total Feeding Costs – Value at Delivery.

Table 5. Performance, Carcass Characteristics and Profitability of Breed Groups in Kansas Steer Futurities from 1974-1988

Item	British	LC	LC × Brit.	MC × Brit.	SC	SC × Brit.	Dairy Cross	Brahman Cross	Longhorn Cross
No. steers	1257	106	2496	201	172	306	53	213	84
Profit, $/hd	72.82	87.08	86.62	96.54	70.58	79.90	94.10	77.16	35.31
Starting wt., lb	615	660	651	631	611	626	684	640	560
Frame score	3.2	4.6	4.2	3.8	2.8	4.0	3.7	4.2	2.6
ADG, lb	2.99	3.32	3.32	3.23	3.06	3.21	3.30	3.10	2.60
Quality grade[a]	6.8	6.0	6.4	6.6	6.5	6.3	7.0	6.4	6.8
Carcass wt., lb	658	736	720	724	677	700	745	699	613
Fat thickness, in	.48	.29	.36	.38	.27	.37	.41	.39	.31
Ribeye area, in^2	12.1	13.5	13.2	13.6	13.1	13.2	12.7	12.7	11.9
Yield grade	2.8	2.1	2.4	2.3	2.1	2.3	2.5	2.6	2.3
Days fed	160	168	166	167	166	165	163	166	171

[a]6.0 = Select +, 7.0 = Choice –.

Table 6. Performance, Carcass Characteristics and Profitability of Frame Score Groups in Kansas Steer Futurities from 1974-1988.

Item	Frame Score 1	2	3	4	5	6	7
No. Head	273	500	712	1027	771	321	50
Profit, $/hd	67.68	77.40	89.48	92.41	89.70	82.56	90.79
Starting wt., lb	585	604	634	662	684	705	747
ADG, lb	2.88	3.06	3.21	3.32	3.39	3.48	3.50
Quality grade[a]	6.8	6.6	6.6	6.4	6.2	5.8	5.6
Carcass wt., lb	644	673	704	733	753	765	802
Fat thickness, in	.43	.41	.40	.36	.33	.28	.27
Ribeye area sq in	12.1	12.5	13.0	13.3	13.5	13.6	14.1
Yield grade	2.6	2.5	2.5	2.4	2.3	2.2	2.1
Days fed	167	164	163	164	165	162	166

[a]6.0 = Select +, 7.0 = Choice –.

BREED AND MANAGEMENT SYSTEM EFFECTS ON FEEDLOT PERFORMANCE AND CARCASS TRAITS

D. T. Hickok, R. R. Schalles, M. E. Dikeman, and D. E. Franke[1]

Summary

Eighty nine steers with different proportions of Angus, Hereford, Charolais, Brahman, and Gelbvieh breeding from rotational and terminal crossbreeding systems were produced in Louisiana and finished at KSU. Half of each breed group was placed in the feedlot at weaning (calves) and the other half as yearlings. Half of the each group was slaughtered at a low (0.3-0.4 in.), and the other half at high (0.5 - 0.6 in.) fat thickness. As percentage of Charolais and Gelbvieh breeding increased, feedlot performance improved. As percentage of Charolais, Gelbvieh, and Angus increased, carcass desirability improved. Steers started on feed at weaning were more efficient in feed conversion and were more profitable than those started as yearlings. Age did not affect carcass marbling or quality grade.

(Key Words: Cattle, Breeds, Management, Performance, Carcass, Returns.)

Introduction

With the availability of cattle with high growth rates and with current economic and consumer diet-health concerns, interest has increased in feeding weaned calves as opposed to the traditional method of backgrounding and then feeding yearlings. Although consumers prefer leaner beef, producers are still paid by the pound on a quality grading system that favors marbling. Under traditional production systems, fast growing cattle are too large at slaughter to meet market specifications. Beef producers need information that will allow them to optimize the relationship between customer preference and profit. This experiment was designed to: 1) compare feedlot performance and carcass characteristics of steers produced from 2-, 3- and 4-breed rotational and terminal crossbreeding systems involving British, Continental, and Brahman breeds and 2) to compare the performance, carcass traits, and economic returns of calves and yearlings.

Experimental Procedures

Steer calves were produced in the spring of 1989 at Louisiana State University (LSU) as part of an ongoing rotational crossbreeding study. The F_1 and 2-, 3-, and 4-breed rotational crossbred progeny were produced using Angus (AN), Hereford (HH), Charolais (CH) and Brahman (BR). Half of the cows of each breed group were bred to Gelbvieh (GV) bulls as a terminal cross. Each of the 18 breed groups was divided in half, with one half (n = 45) shipped to KSU at weaning (fall, 1989) and the remainder (n = 44) grazed on rye grass pasture at LSU and shipped to KSU as yearlings (May, 1990). Upon arrival at KSU, breed groups were randomly assigned to pens of 5 or 6 head and started on a ration of sorghum silage, cracked corn, and a soybean meal-urea protein supplement. The percent silage was decreased from 75% to 15% over a 4-wk period. Cattle were weighed prior to shipping, after arrival at KSU, and every 28 d until slaughter. A random half of each breed-age management group was slaughtered when ultrasound backfat measurements were between 0.3 and 0.4 in., and the other half was slaughtered when measurements were between 0.5 and 0.6 in.

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For statistical analysis, the 18 breed groups were consolidated into seven breed groups, so that at least 50% of one breed occurred in each group (Table 1). Data were analyzed using Least Squares procedures to evaluate breed groups, with the effects of calves vs. yearlings and backfat endpoint removed. Regression analysis also was performed to substantiate the analysis of variance.

Results and Discussion

The seven groups used in the analysis were high percentage AN, high percentage HH, high percentage CH, half GV with a high percentage AN, half GV with a high percentage HH, half GV with a high percentage CH, and half GV with a high percentage BR.

Table 1. Percentage of breed in each breed group

	Breed Group						
Breed	1	2	3	4	5	6	7
Angus	64	18	0	26	0	0	0
Hereford	8	64	0	1	25	3	0
Charolais	11	4	62	1	0	26	17
Brahman	17	14	38	22	25	21	33
Gelbvieh	0	0	0	50	50	50	50
No. Calves	26	27	13	8	7	5	3

Least Square analysis for the 12 production and carcass traits by breed group are shown in Table 2. Slaughter and carcass weights increased as the percentage CH, GV, and AN increased and decreased as percentage HH increased. Increased percentage HH decreased slaughter age and number of days on feed, whereas increased percentage of CH and GV increased those parameters. ADG was increased most by CH and decreased most by BR. Total gain was increased by CH, GV, and AN and decreased by BR and HH.

As the percentage of BR increased, marbling and quality grade tended to decrease. Even though ultrasound was used to estimate fat thickness slaughter endpoint, adjusted carcass backfat thickness varied among breed groups. Increased percentage CH and GV breeding decreased the adjusted backfat, whereas increased percentage of HH increased adjusted backfat. An increase in percentage HH increased numerical yield grade, and an increase in percentage CH decreased (improved) numerical yield grade. Ribeye area was increased by CH and GV blood and decreased by HH.

The second part of the analysis compared calves vs. yearlings for the same 12 production and carcass traits plus total TDN and feed/gain ratio (Table 3). There were significant differences between calves and yearlings in almost all traits measured. The two exceptions were average marbling score and quality grade. However, 67% of the calves and 54% of the yearlings graded Choice, with the average of each group being very close to Choice^0 grade.

Cattle were slaughtered at an endpoint determined by an ultrasound measurement of backfat over a 120 d period. This differs from other production systems where all cattle in a group are generally slaughtered at one time. Calves reached the fat thickness endpoint at lighter slaughter and carcass weights than the yearlings. However, both groups produced acceptable weight carcasses on the average. Although calves were slaughtered at a younger age, they required 85 more days on feed than the yearlings. They also consumed an average of 362 lb more TDN, gained an average of 156 lb more, and converted feed to gain more efficiently than the yearlings. Average daily gains from the shipping weight in Louisiana to slaughter weight in Kansas were less for the calves than for the yearlings. ADGs for both calves and yearlings were lower than expected in commercial production. Because slower gaining cattle were required to reach the same

fat thickness endpoints as faster gaining cattle, greatly extending the average feeding period. Although, under commercial production, these slower gaining cattle would have been slaughtered earlier, the difference between ADG of the two groups should be a valid comparison of relative performance.

The yearlings had larger ribeyes and higher numerical yield grades because they had heavier carcasses with more fat thickness; however, both groups were within acceptable ranges. The greater fat thickness on yearlings was probably due to inaccuracy of ultrasound estimation of fat thickness.

A cost and return analysis of calves vs. yearlings is presented in Table 4. Trucking costs, which include shipping the cattle from LSU to KSU, are higher than normal because trucks were not full; however, the per head cost was about equal for both groups. Feed cost per lb of TDN was about the same for both groups ($0.068 for the calves and $0.074 for the yearlings), so differences in feed costs reflect consumption differences. Even with higher calf cost per lb, it was more profitable to feed calves than yearlings. The single most important factor affecting the profit advantage of the calves was their superior feed efficiency.

Table 2. Least Squares Means for Performance and Carcass Characteristics by Breed Group

Trait	Breed Group[c] 1	2	3	4	5	6	7
Shipping Wt.,lb	690[a]	672[a]	710[ab]	751[b]	708[ab]	700[ab]	779[b]
Slaughter Wt,lb	1195[b]	1091[a]	1245[b]	1198[b]	1186[b]	1179[ab]	1322[b]
Slaughter Age,d	492[a]	489[a]	515[b]	534[b]	526[b]	533[b]	535[b]
Days Fed	179[a]	173[a]	208[b]	211[b]	215[b]	217[b]	207[ab]
Total Gain,lb	500[a]	418[b]	536[a]	446a[ab]	477[ab]	478[ab]	545[a]
ADG,lb	2.76[a]	2.52[a]	2.62[a]	2.14[b]	2.25[b]	2.30[ab]	2.78[a]
Carcass wt.,lb	738[a]	6668[b]	764[a]	731[a]	733[a]	719[ab]	797[b]
Marbling	Sm61[a]	Sm23[a]	Sm04[a]	Sl88[a]	Sm08[a]	Sm18[a]	Sm23[a]
[d]Quality Grade	Ch13[a]	Se91[a]	Se91[a]	Se81[a]	Se91[a]	Se99[a]	Se98[a]
[e]Adjusted BF,in.	.54[a]	.54[a]	.36[b]	.42[b]	.49[a]	.29[b]	.47[ab]
Yield Grade	3.1[a]	2.9[a]	2.6[ab]	2.7[ab]	3.0[a]	2.2[b]	3.1[a]
Ribeye Area,in^2	12.7[ab]	12.2[a]	13.6[b]	13.3[b]	13.5[b]	13.3[ab]	13.1[ab]

[ab]Values in the same row with different superscript letters are different (P < .05).
[c]Breed groups are the same as described in Table 1.
[d]Quality grade Select(Se) and Choice(Ch) are followed by a numeric value, which is the % within the grade.

Table 3. Performance during the Finishing Phase of Crossbred Cattle Finished as Calves or Yearlings

Trait[c]	Calves	Yearlings
Shipping Wt., lb	534[a]	881[b]
Slaughter Wt., lb	1069[a]	1260[b]
Slaughter Age, d	448[a]	571[b]
Days Fed	236[a]	151[b]
Total TDN[d], lb	2898[a]	2536[b]
ADG,lb	2.24[a]	2.58[b]
Feed/Gain	5.65[a]	6.76[b]
Total Gain, lb	535[a]	379[b]
Carcass Wt., lb	663[a]	771[b]
[e]Quality Grade	Sel 88[a]	Sel 89[a]
Yield Grade	2.6[a]	2.9[b]
Ribeye Area, in^2	12.6[a]	13.4[b]
[f]Marbling	Sm 06[a]	Sm 08[a]
Adj. Carcass Fat, in	0.40[a]	0.49[b]

[ab]Values in a row with different superscripts are different($P < .05$).
[c]All values are expressed on a per head basis.
[d]TDN is Total Digestible Nutrients fed during the feeding period.
[e]Quality grade Select(Sel) is followed by a numeric value, which is the % within the grade.
[f]Marbling score Small(Sm) is followed by a numeric value, which is the % within the score.

Table 4. Economics of Feeding Crossbred Cattle as Calves or Yearlings

Item	Calves (n = 46)	Yearlings (n = 44)
Expenses		
Feeder Cost[a]	$ 476	$ 674
Trucking	43	46
Yardage($.15/head/day)	32	23
Feed[b]	198	187
Interest(11%)	45	37
Total Expenses	$ 794	$ 967
Income		
Cattle Sales[c]	$ 824	$ 960
Profit or (Loss)/head	$ 29	($ 6)

[a]Feeder cost = $ .92/lb for calves and $ .765/lb for yearlings with a 4% shrink on the shipping weight.
[b]Consisted of corn, silage and soybean-urea protein supplement with Rumensin at costs of $0.068 for calves and $0.074 per lb for yearlings.
[c]Avg prices received were $1.23 for calves and $1.236 for yearlings per lb of hot carcass.

SEASONAL VARIATION IN QUALITY OF GRAZED FORAGE DURING A DROUGHT YEAR[1]

R. C. Cochran and E. S. Vanzant

Summary

Concentration of fiber in the forage selected by beef steers grazing bluestem range during a drought year (1989) was highest in the winter but declined substantially in the spring and remained fairly constant throughout summer. Conversely, crude protein concentration was lowest during the winter, peaked during the spring, declined through early summer, but increased in the late summer before declining during the fall. Precipitation was well below normal in all months except August, September, and October, which were above normal. Improvement in forage quality during those months was probably due to stimulation of late-season forage growth in response to elevated precipitation.

(Key Words: Range, Forage, Protein, Fiber, Drought.)

Introduction

Performance of beef cattle grazing native range depends on both quality of forage selected and quantity of forage consumed. The ability of producers to accurately predict periods of nutrient deficiency and, thus, the need for supplementation requires knowledge of seasonal changes in forage intake and quality. Variation in environment between years can influence those characteristics. Because cattle are very selective grazers, hand-clipped samples do not accurately reflect the quality of grazed forage. Therefore, our objective was to depict the seasonal changes in quality of forage selected by esophageally fistulated beef steers grazing bluestem range during a drought year.

Experimental Procedures

Five, mature, Angus x Hereford steers (average wt = 1700 lb) with esophageal fistulas were used to monitor seasonal changes in quality of forage selected. All steers grazed as a single group on bluestem range and were confined to a 5-acre trap during each of the 3- to 4-day collection periods. Number of days in each collection period varied depending on whether esophageal samples were successfully collected from all animals on the first 3 days. To minimize regurgitation, steers were gathered in the early morning on collection days and with-held from grazing (with access to water) during the morning. Samples of grazed forage were collected via the esophageal fistula in the early afternoon during a 30-minute grazing period. Sample bags were lined with plastic to allow collection of both grazed forage and saliva. Samples were placed on ice, transported to the laboratory, frozen immediately, and later freeze-dried in preparation for chemical analyses. Samples were collected near the end of each month. The pasture was burned after the April collection. Data were analyzed with a repeated measures approach using the repeated option of the general linear models procedure of SAS. Most high-order, orthogonal, polynomial contrasts were found to be significant for both fiber and protein concentration.

[1]Appreciation is expressed to Gary Ritter, Wayne Adolph, Kelly Brandyberry, Kirk Vanzant and Jane Beatty for their invaluable assistance in conducting this trial.

Results and Discussion

Precipitation was well below normal (Figure 1) throughout the course of the study, with the exception of August, September, and October, when precipitation was well above normal. For steers grazing bluestem range during the typical season-long stocking period (May - October), neutral detergent fiber (NDF) concentration in grazed forage is usually lowest in the early spring followed by a rise in concentration as the growing season progresses (Peischel, 1980, M.S. Thesis, KSU). Variability in the NDF concentration was noted in the late season in Peischel's study, apparently because of variability in late season rains and its influence on forage growth. A similar pattern was evident for the NDF concentration (Figure 2) in our study during the same period of time. NDF concentration was highest in the winter months when the plants were not only dormant but also had weathered. Because the pasture was not burned until after the April collection, the April sample was a mixture of dormant forage and forage growth. Cool-season grasses may have made a valuable contribution to quality of diet selected during that period. As a result, NDF concentration during April appeared to be intermediate between the winter values and those observed after burning. Crude protein (CP) concentration in the Peischel study was highest in the early spring and continued to drop through late summer, after which it appeared to stabilize. A similar pattern was evident in our study (Figure 3) except that CP concentration increased during August and September, followed by a decline in November. We interpret this pattern as resulting from late-season forage growth stimulated by the above average precipitation in August through October, following extremely dry conditions during the early growing season. Crude protein concentrations were lowest during the winter, with a slight rise in April, probably attributable to the mixture of dormant and vegetative forage selected by animals just before burning.

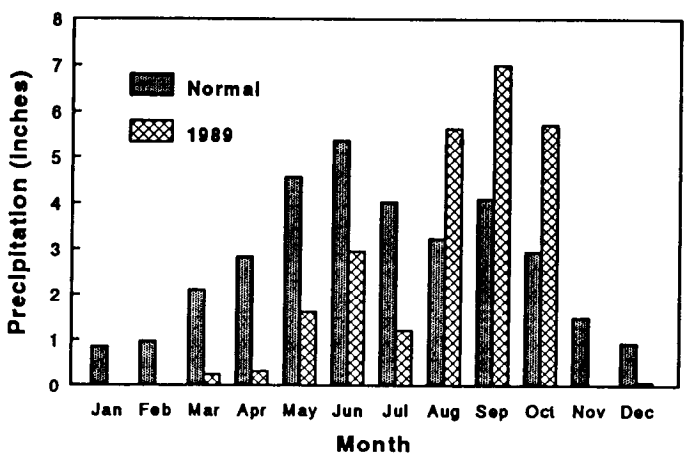

Figure 1. Precipitation Patterns During 1989

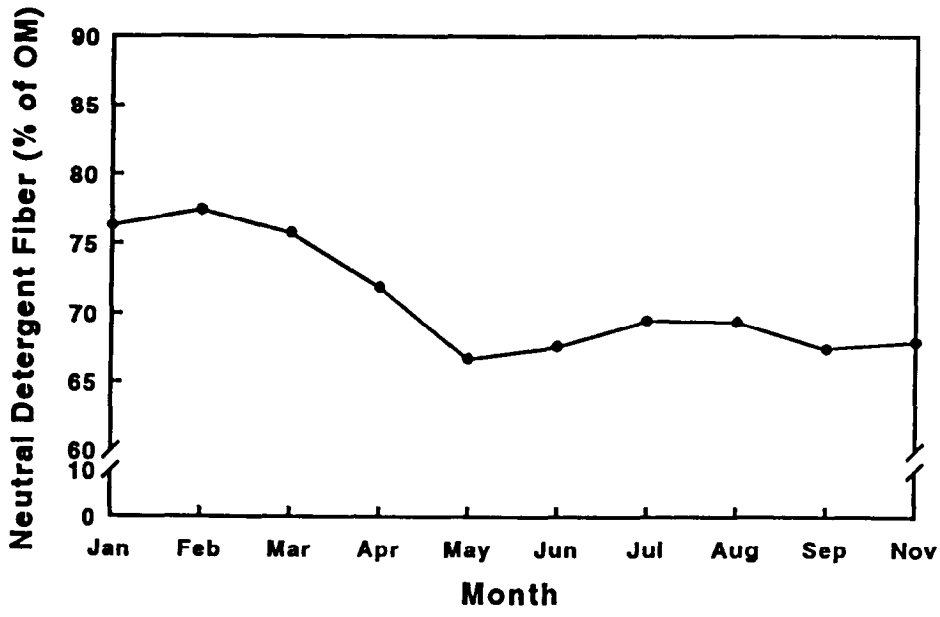

Figure 2. Influence of Season on Fiber Concentration in Grazed Forage

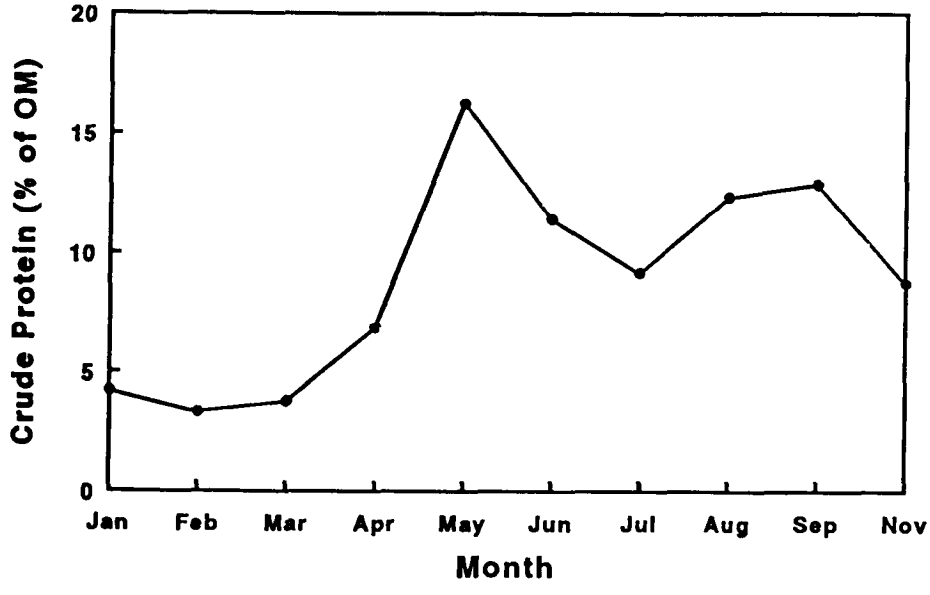

Figure 3. Influence of Season on Protein Concentration in Grazed Forage

INCREASING LEVELS OF GRAIN SUPPLEMENTATION FOR INTENSIVE-EARLY STOCKED STEERS: THREE-YEAR SUMMARY

R. C. Cochran, C. E. Owensby, R. T. Brandt, Jr., E. S. Vanzant, and E.M. Clary[1]

Summary

During the initial 3 years of a 4-year experiment, average daily gain tended to increase in direct proportion to increasing levels of grain sorghum supplementation (2.3, 2.5 and 2.7 lb gain per day for the control and 2 and 4 lb supplement per day, respectively). The amount of grass remaining in the pastures at the end of the growing season (October 1) was greater in each of the 3 years when cattle were supplemented at 4 lb/day. During the 2 years (1989 and 1990) that feedlot performance was monitored, level of supplementation for grazing steers did not influence subsequent feedlot gain or efficiency.

(Key Words: Intensive-early Stocking, Supplementation, Grain Sorghum, Milo.)

Introduction

Intensive-early stocking is becoming relatively well accepted in the tallgrass prairie region. However, limited information is available regarding the value of grain supplementation for stockers managed within that system. In order to determine the appropriate use of supplementation within intensive-early stocking programs, information describing effects of supplementation on pasture characteristics as well as animal performance during both the grazing and finishing phases is necessary. Therefore, a 4-year study is being conducted with the objective of monitoring average daily gains and changes in forage production when intensive-early stocked steers are supplemented with increasing levels of grain sorghum. During 1989 and 1990, subsequent feedlot performance was monitored. This report is a compilation of data from the first 3 years.

Experimental Procedures

British × Zebu crossbred steers were randomly assigned to six, 60-acre pastures during each of the 3 years. Stocking rate (1.5 acres/550 lb steer) was equal among pastures. Number of steers per pasture was adjusted depending on starting weights to ensure that the same stocking rate was maintained for each year. Pastures were randomly assigned to a control or two supplementation treatments (two pastures/treatment): 2 or 4 lb rolled sorghum grain per head daily. Supplemented groups were bunk-fed daily at approximately 1:00 - 2:00 pm. All pastures were burned in late April, and subsequently steers grazed the pastures from early May through mid-July. Weights were taken after an overnight stand without feed or water at trial initiation, mid-June, and at trial termination. Conversion efficiency (lb feed/lb extra gain) was calculated by dividing the quantity of supplement fed to a treatment group during a given period by the amount of gain above the unsupplemented steers during the same period. Steers were implanted during initial processing and had unlimited access to a Bovatec®/mineral mixture during the entire trial. Consumption of that mixture was not different ($P > .10$) among treatments and averaged .17 lb/day (approximately 125 mg Bovatec®/head/day). Forage remaining was measured in the pastures at the end of the

[1]Appreciation is expressed to Mr. Gary Ritter, Mr. Wayne Adolph, and the student workers at the Range Research Unit for their invaluable assistance in conducting this trial.

grazing period (July 15) and at the end of the growing season (October 1) by clipping 10, ½ m^2 frames at random locations within each pasture. Following the grazing phase in 1989 and 1990, a representative group of steers from each pasture (n = 192 in 1989, n = 144 in 1990) was randomly allotted to a finishing trial to measure the effects of supplementation on subsequent finishing performance.

Results

Although response to supplementation during the early portion of the grazing period (Figure 1, May - Early June) varied by year, generally little performance difference was evident among treatments. In contrast, average daily gain during the latter part of the grazing period (mid-June to mid-July) increased (P = .06) with increasing level of supplement. A similar trend (P = .18) was evident over the entire grazing period. Conversion efficiency followed the same pattern as that observed for daily gain and, when averaged over the entire grazing period, typically fell in the range of 9 to 10 lbs of grain for each additional lb of gain above the control group. Compensatory responses in gain, intake, or gain:feed ratio were not evident during the subsequent finishing phase (Table 1). Weight differences among treatment groups at the start of finishing tended to remain intact throughout finishing and, as a result, there was an increase (P = .07) in hot carcass weight that corresponded to level of grain supplementation during the pasture phase. Carcass quality characteristics did not differ (P > .10) among treatments.

When grass and forbs remaining in the pasture were measured at the end of the 1990 grazing period (Figure 2, mid-July), little difference was evident among treatments. In contrast, during 1988 and 1989, more grass remained at the end of the grazing period in those pastures where steers received 4 lb/day of supplement. Increased response to supplementation during 1988 and 1989 was probably due to the reduced forage production that resulted from drought during those years. At the end of the growing season, more grass was observed to be left in the pastures with the highest level of supplementation. Quantity of forbs remaining was not different among treatments.

Table 1. Influence of Grain Level during the Grazing Period on Subsequent Feedlot Performance and Carcass Characteristics of Steers (2-yr Summary)

	Grain Level (lb/d)			Standard	Probability Value	
Item	Control	2	4	Error	Linear	Quadratic
Initial Weight (lb)	780	796	807	10.4	.11	.88
Final Weight (lb)	1173	1191	1194	9.6	.16	.55
Dry Matter Intake (lb/d)	22.3	22.5	22.4	.2	.87	.51
Average Daily Gain (lb/d)	3.48	3.51	3.44	.06	.68	.53
Gain:Feed Ratio	.156	.156	.154	.003	.61	.89
Hot Carcass Weight (lb)	720	731	737	5.7	.07	.70
Dressing Percentage	64.1	63.8	64.6	.20	.07	.07
Yield Grade	3.00	3.05	2.99	.09	.95	.61
Marbling	Sm^{27}	Sm^{33}	Sm^{20}	.09	.61	.40

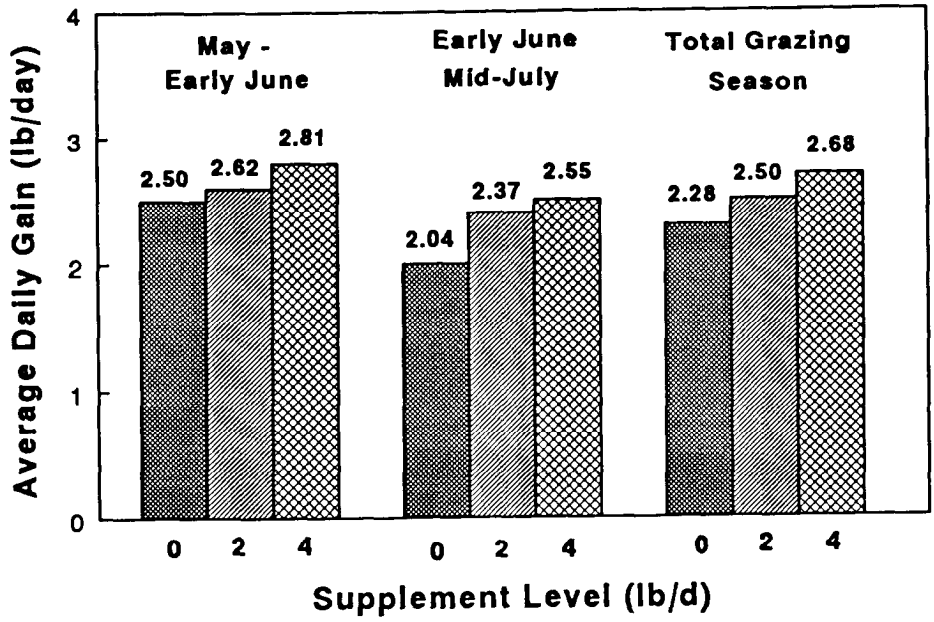

Figure 1. **Influence of Level of Grain Supplementation on the Average Daily Gain of Intensive-early Stocked Steers - Three Year Summary (linear increase in gain with increasing supplement level; P=.07 for early June to mid-July and P=.18 for the total grazing period).**

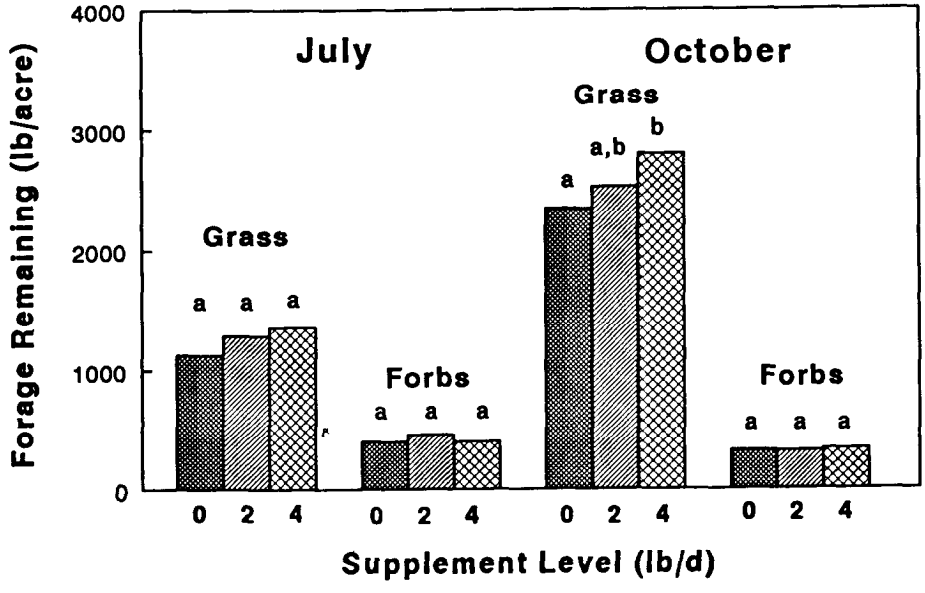

Figure 2. **Influence of Level of Grain Supplementation on the Forage Remaining in Intensive-early Stocked Pastures at Mid-July and Early October (1990 data; columns within forage type accompanied by different letters differ, P<.10).**

INFLUENCE OF INCREASING AMOUNTS OF SUPPLEMENTAL ALFALFA HAY ON INTAKE AND UTILIZATION OF DORMANT, WINTER-HARVESTED, BLUESTEM-RANGE FORAGE BY BEEF STEERS[1]

E. S. Vanzant and R. C. Cochran

Summary

Sixteen, ruminally cannulated, beef steers were used in an intake/digestion experiment to determine the effects of supplementing a dormant, winter-harvested, bluestem range, forage diet with increasing amounts of moderate quality alfalfa. Steers were allowed ad libitum access to dormant forage and were supplemented with alfalfa hay at: 1) .23, 2) .47, 3).70, and 4) .94 % of BW on a dry matter (DM) basis. As the amount of supplemental alfalfa increased, dormant forage intake decreased, but total DM intake increased. Dry matter digestibility was unaffected by treatment, and only minor changes were noted for ruminal fermentation characteristics. Changes in ruminal fill and liquid dilution rates indicated an increase in digesta passage with increasing amounts of supplemental alfalfa hay. Although these results indicate that maximal digestible nutrient intake is attained at the highest level of supplementation, levels of nutrient intake and fermentation patterns indicate that adequate performance may be attained at lower levels of supplementation.

(Key words: Protein Supplement, Winter Range, Intake, Digestibility, Alfalfa.)

Introduction

Protein supplementation is an integral part of the nutritional management of beef cows maintained on winter range. Enhancing of both the intake and digestibility of poor quality forages by protein supplementation has been well documented. Alfalfa hay is a readily available and relatively inexpensive protein source for many cow-calf producers. However, unlike concentrate supplements, alfalfa hay, with its substantial fiber component, might contribute to ruminal distension and thereby limit the intake-stimulatory effects of the protein it supplies. The objective of this experiment was to determine the impact of various amounts of supplemental alfalfa hay on the intake and utilization of dormant, winter-harvested, bluestem-range forage by beef steers.

Experimental Procedures

Sixteen ruminally cannulated steers (avg initial wt = 641 lb) were individually penned and fed for the duration of the experiment. Dormant, winter-harvested, bluestem-range forage (CP = 2.1%; NDF = 76.0%) was fed each morning at 140% of each animal's previous 5-d average intake. Supplement treatments consisted of alfalfa hay (16.8% CP; 46.5% NDF) fed at: 1) .23, 2) .47, 3).70, and 4) .94% of BW/head daily (DM basis). Alfalfa was fed 2 hours before dormant forage to ensure adequate time for all treatment groups to consume the alfalfa. Levels used in this experiment, if fed to mature 1000 lb cows in the third trimester of gestation, would provide 25, 50, 75, and 100%, respectively, of their crude protein requirements from the supplement alone.

Steers were adapted to diets for 14 d. Voluntary intake was measured over the next 7-d period. Total fecal collections were made

[1]The authors express their appreciation to Tim Beck, Kirk Vanzant, Gary Ritter and Wayne Adolph for their expert assistance in conducting this experiment.

during the next 7 days. Then the steers' rumens were manually emptied for ruminal fill measurements. These ruminal evacuations were performed just prior to (0 h) and 6 h after feeding alfalfa hay. The following day, Cr:EDTA, a liquid flow marker, was added to the rumen of each steer in a pulse dose. Ruminal fluid samples were obtained at various times after dosing to determine liquid dilution rate, pH, and volatile fatty acid concentrations.

Results and Discussion

The intake of dormant forage was depressed in a linear fashion ($P = .02$) with increasing alfalfa hay (Table 1). However, alfalfa did not replace forage at a 1:1 ratio. Rather, an increase of one unit in alfalfa hay consumption resulted in a decrease of .4 units in dormant forage intake. Therefore, the total DM intake increased linearly ($P < .01$) with increasing alfalfa hay. Based on these intakes, mature 1000 lb British cross cows consuming alfalfa hay at similar percentages of their BW would be expected to meet 43, 67, 91, and 113% of their crude protein requirements on the .23, .47, .70, and .94% BW treatments, respectively.

Although the proportion of the total diet provided by alfalfa increased from 14% on the low level of alfalfa to 46% on the high level, no treatment differences were found ($P > .10$) for DM digestibility. Because total intake increased with no change in digestibility, total digestible nutrient intake would be highest with the highest level of supplemental alfalfa.

The influence of treatment on ruminal fill depended ($P < .10$) on the time of ruminal evacuation. Prior to feeding, when fill values would be expected to be at a minimum, liquid fill decreased linearly ($P = .06$) and DM fill tended to decrease linearly ($P = .14$) with increasing alfalfa hay. However, 6 h after feeding alfalfa hay (4 h after feeding dormant forage), neither DM nor liquid fill differed ($P > .10$) among treatments. Thurs, one would expect a higher rate of digesta passage as levels of alfalfa hay increased. Indeed, liquid dilution rates increased linearly ($P = .02$) with increasing level of alfalfa hay. An increased passage rate could account for the lack of effect on DM digestibility with increasing alfalfa.

Only minor effects were noted for fermentation variables measured. Treatments had no effect ($P > .10$) on ruminal pH at any sampling time. Total volatile fatty acid concentrations tended ($P = .18$) to increase linearly with increasing alfalfa hay. Although molar percentage of acetate in the rumen decreased linearly ($P = .04$) with increasing alfalfa hay, the magnitude of the change was very slight, and no changes were noted ($P > .10$) for molar percentage of propionate or acetate:propionate ratio.

Our experiment indicates that digestible nutrient intake by beef steers increased as a dormant, bluestem-range, forage diet was supplemented with increasing amounts of alfalfa hay from .23 to .94 % of BW. This increase was primarily a result of increased total intake, as total tract DM digestibility remained unaffected, perhaps because of increased digesta passage rates. Studies are underway to determine the impact of the highest three levels of alfalfa hay supplementation on performance of grazing beef cows.

Table 1. Influence of Amount of Supplemental Alfalfa Hay on Intake, Digestibility, Ruminal Fill, Liquid Dilution, and Ruminal Fermentation in Beef Steers Consuming Dormant, Bluestem-Range Forage

	Alfalfa hay DM, % body weight					Effect[a]	
Item	.23	.47	.70	.94	SE	L	Q
Steer wt, lb	643	635	641	645			
DM Intake, % BW							
Dormant forage	1.44	1.32	1.37	1.12	.08	.02	.36
Alfalfa hay	.23	.47	.70	.94			
Total	1.67	1.79	2.08	2.05	.07	.00	.35
DM Digestibility, %	45.9	48.8	48.7	48.5	1.6	.30	.34
0 h Evacuation							
DM fill, % BW	1.8	1.8	1.4	1.4	.2	.14	.99
Liquid fill, % BW	17.5	18.9	15.1	15.5	1.0	.06	.61
6 h Evacuation							
DM fill, % BW	2.4	2.2	2.3	2.2	.0	.50	.78
Liquid fill, % BW	19.5	21.3	18.9	20.4	1.0	.95	.85
Liquid Dilution Rate, %/h	4.0	4.7	5.2	5.8	.5	.02	.96
Ruminal pH	6.60	6.64	6.59	6.63	.06	.82	.98
Ruminal VFA, mM	81.5	84.0	90.1	87.8	3.8	.18	.55
Ruminal acetate, mol/100 mol	77.8	77.4	76.3	76.5	.4	.04	.51
Ruminal propionate, mol/100 mol	15.6	15.7	15.9	15.5	.2	.90	.37
Acetate/Propionate	5.0	4.9	4.8	5.0	.1	.57	.36

[a]Probability of a greater F value. L = linear change with increasing alfalfa. Q = quadratic change with increasing alfalfa.

DEHYDRATED ALFALFA PELLETS AND SOYBEAN MEAL/GRAIN SORGHUM IN STEP-UP WINTER SUPPLEMENTATION PROGRAMS FOR SPRING-CALVING BEEF COWS[1]

E. S. Vanzant, R. C. Cochran, L. R. Corah, and G. H. Kiracofe

Summary

The performance response to a stepwise increase in the level of supplement fed to cows across the winter supplementation period was studied by feeding 112 Hereford × Angus cows the following treatments: dehydrated alfalfa pellets (DEHY) or soybean meal/grain sorghum (SS), each either level-fed (constant daily amount from December 1 to calving) or fed in a step-up program (low level from December 1 to 30; moderate level from December 31 to January 29; high level from January 30 to calving; avg = amount fed with level-feeding). Cow weight and condition changes and calf performance were favored by the step-up supplementation program when SS was fed. When DEHY was fed, cow weight and condition changes favored level-feeding. Weight and condition changes generally favored the DEHY group over the SS group. No effects were found for the reproductive characteristics measured. These results indicate that potential benefits of step-up winter supplementation programs depend on the type of supplement being fed. All of the supplementation programs appeared adequate to support desirable levels of reproductive performance.

(Key Words: Beef Cows, Protein Supplement, Dehydrated Alfalfa Pellets, Winter Range.)

Introduction

Both dehydrated alfalfa pellets (DEHY) and soybean meal/grain sorghum (SS; at least 20% CP) supplements fed to supply 1 lb of CP per head daily will provide adequate nutrition to spring-calving beef cows grazing winter range (KAES Report of Progress 567). These winter supplements might be more efficiently utilized, if the amount fed was more closely matched to the cow's immediate requirements. Earlier (KAES Report of Progress 592), we evaluated a step-up supplementation program in which an average of 4 lb DEHY per head daily (avg .8 lb CP/head daily) was fed to cows, such that they received less feed in early winter and more in late winter, closer to parturition. In that research, we found no advantage to step-up feeding. However, it is possible that when feeding greater amounts or different types of supplements, step-up feeding may offer benefits. The present experiment was conducted to determine the impact of step-up feeding on the utilization of DEHY and SS supplements when fed to provide an average of about 1.0 lb CP/head daily during the winter supplementation period.

Experimental Procedures

One hundred twelve, pregnant, Hereford × Angus cows (avg initial wt = 1103 lb; avg initial body condition = 5.5) were assigned to four supplement treatments: 1) DEHY (17.9% CP) fed at 5.8 lb dry matter (DM)/head daily (1.04 lb CP/d) from December 1 to calving; 2) DEHY fed at the same total amount across the

[1]The authors would like to thank Gary Ritter, Wayne Adolph, Buck Root, and Preston Hickman for their invaluable assistance in conducting this experiment.

winter (actual avg intake = 5.7 lb/head daily) but stepped up at monthly intervals: 2.9 lb/head daily from December 1 to 30, 4.4 lb/head daily from December 31 to January 29, and 8.9 lb/head daily from January 30 to calving; 3) SS (26.8% CP) fed at 4.3 lb DM/head daily (1.15 lb CP/d) from December 1 to calving; and 4) SS fed at same total amount across the winter (actual avg intake = 4.2 lb/head daily) but stepped up at monthly intervals: 2.1 lb/head daily from December 1 to 30, 3.2 lb/head daily from December 31 to January 29, and 6.5 lb/head daily from January 30 to calving. Treatment ended after calving (avg calving date = March 8) and all cows received 10 lb/head alfalfa hay daily until sufficient new grass was available. The animals grazed pastures that were predominantly big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), and little bluestem (*Andropogon scoparius*).

On days 0, 85, 100 (within 48 h postpartum), 168, and 365, the cows were weighed and scored for body condition (scale: 1 = extremely thin, 9 = extremely obese) following an overnight stand without access to feed or water. Calves were weighed within 48 h after birth and at average ages of 68 and 224 d (weaning). The number of cows cycling before the breeding season was determined from blood progesterone. Cows were pasture-mated as a single herd to a group of four Angus bulls during a 60-d breeding season. Pregnancy and fetal ages (for estimating conception dates and calving intervals) were determined by rectal palpation (August 29).

Results and Discussion

By d 85, DEHY cows had gained more ($P < .10$) weight than SS cows, and level-fed cows had gained more ($P < .10$) than the step-fed cows (Table 1). By d 100 (within 48 h after calving), supplementation method had no effect on cumulative weight loss, but DEHY cows had lost less weight ($P < .10$) than SS cows. By the beginning of the breeding season, differences between DEHY and SS were confined to the level-fed group ($P < .10$). One year after starting the experiment, DEHY cows on the step-up program had smaller cumulative weight gains ($P < .10$) than either the level-fed DEHY cows or the step-up SS cows.

Treatments had no effect on cumulative body condition changes by d 85. By d 100, level-fed SS cows had lost more ($P < .10$) body condition than the step-fed SS cows. By the beginning of the breeding season, level-fed DEHY cows had lost less condition than either their step-up DEHY or their level-fed SS counterparts. However, by 365 d after the experiment started, all treatment differences in body condition had disappeared.

Calf birth weights and weaning weights were unaffected ($P > .10$) by supplemental treatments. In general, calf gains followed cow weight and condition changes; step-up feeding was favored within the SS group, whereas level-feeding was favored within the DEHY group.

Neither supplement type nor method affected the reproductive characteristics we measured ($P > .10$). Pregnancy rates averaged 97%, with 72% cycling at the beginning of the breeding season and 64, 30, and 6% bred in successive thirds of the breeding season. The calving interval averaged 366 d.

Table 1. Effect of Type and Method of Winter Protein Supplementation on Cumulative Weight Changes and Body Condition Changes in Beef Cows and Calf Weights and Gains

	Dehydrated Alfalfa Pellets		Soybean meal/Grain sorghum			
Item	Level-fed	Step-up	Level-fed	Step-up	SE	Effects[a]
No. cows	28	28	28	28		
			Cow Weights, lb			
Starting Weight	1095	1117	1097	1104	21	
Changes						
d 85	43	21	8	2	7	T,M
d 100 (calving)	-104	-109	-161	-155	7	T
d 168 (breeding)	-139[c]	-157[cd]	-167[d]	-157[cd]	7	I
d 365	36[c]	3[d]	31[c]	50[c]	10	I
			Condition Scores (CS)[b]			
Starting CS	5.6	5.5	5.6	5.5	.1	
Changes						
d 85	-.1	-.2	-.1	-.2	.1	
d 100 (calving)	-.2[c]	-.3[c]	-.5[d]	-.2[c]	.1	I
d 168 (breeding)	-.1[c]	-.3[d]	-.4[d]	-.3[d]	.1	I
d 365	0	-.1	0	.1	.1	
			Calf Performance			
Birth wt, lb	86	90	84	87	2	
68-d ADG, lb	2.0[c]	1.9[cd]	1.8[d]	2.0[c]	.1	I
224-d ADG, lb	2.2[cd]	2.1[c]	2.1[c]	2.3[d]	.1	I
Weaning wt, lb	581	565	561	594	14	

[a]T = Supplement type effect ($P < .01$); M = Supplementation method effect ($P = .08$); I = Supplement type × method interaction ($P < .10$).
[b]Body condition score on a scale of 1 - 9.
[cd]Means within a row without common superscripts differ ($P < .10$).

PERIPARTURIENT CHANGES IN INTAKE, RUMEN CAPACITY, AND SELECTED BLOOD METABOLITES IN BEEF COWS

T. A. Stanley, R. C. Cochran, D. L. Harmon, and E. S. Vanzant

Summary

Four, ruminally cannulated, Hereford × Angus cows were used to study factors associated with feed intake patterns around parturition. Feed intake during the final trimester of gestation was relatively stable, in spite of a noticeable decrease in ruminal capacity. Postpartum feed intake appeared to increase, as did ruminal capacity. Blood progesterone fell after parturition, whereas estradiol did not change except for a large rise around parturition. Some plasma metabolites measured differed before and after calving; however, magnitude and patterns of change do not suggest a direct relationship with intake.

(Key Words: Feed Intake, Ruminal Capacity, Gestation.)

Introduction

The variation in voluntary intake by beef cows can be paritally attributed to alterations in physiological status. Although studies indicate that voluntary intake varies significantly between pregnant and lactating animals, little work has specifically concentrated on changes in intake, fill, and passage rate during pregnancy. These changes must be identified to efficiently manage the pregnant cow for optimum performance. Our objective was to determine the association between intake patterns around parturition and ruminal fill, digesta passage, and blood concentrations of hormones and metabolites in beef cows.

Experimental Procedure

Four, ruminally cannulated, Hereford × Angus cows were synchronized and bred within a 2-week period to the same Angus bull. Seventy days prior to calving, the cows were moved to individual (10' x 10') pens in a temperature-controlled room. Chopped alfalfa hay was offered every afternoon at 130% of the previous 5 days' intake. Refused feed was weighed and subsampled for future analysis.

Ruminal dry matter fill and capacity were estimated every 2 weeks from 70 days prepartum to 21 days postpartum by total removal of ruminal contents and filling the rumen with water.

Plasma and serum were collected from each cow every 3 days up to approximately 14 days prepartum and daily from 14 days prepartum through 21 days postpartum. Plasma was analyzed for glucose, total protein, cholesterol, triglyceride, and blood urea nitrogen (PUN). Serum was analyzed for estrogen and progesterone.

Results and Discussion

All four cows maintained their alfalfa hay intake up to the day of parturition, despite a decrease in capacity of the rumen (Figure 1). Rumen dry matter fill changed with ruminal capacity, so percentage of rumen capacity filled remained relatively constant (Figure 2). Although estradiol was not different before and after calving (Table 1), we observed a steep rise and subsequent decline associated with parturition. Progesterone declined immediately following parturition. This is attributable to

destruction of the corpus luteum which maintained pregnancy. Most observed blood metabolites were not significantly different with the exception of PUN and triglycerides. The change in PUN was relatively minor and may reflect increased protein breakdown supporting the onset of lactation. The decline in triglycerides was likely due to lipid uptake by the mammary gland.

According to our data, factors other than reticulo–rumen capacity affected diet consumption. Other observations of feed intake by pregnant cows near term have shown a decline in feed intake in the last 1 or 2 weeks. However, those observations have often included a diet change near parturition or did not involve an all-forage diet. Further sample analysis may reveal that changes in digesta passage rate and diet digestibility occurred around parturition.

Table 1. Prepartum and Postpartum Means of Selected Blood Metabolites

Item	Prepartum	Postpartum
Estradiol, pg/ml[a]	50.96	1.59
Progesterone, ng/ml	6.64[b]	.62[c]
Total Protein, g/dl	7.63	7.49
Glucose, mg/dl	64.1	65.1
Cholesterol, mg/dl	74.65	79.53
Triglycerides, mg/dl	10.52[b]	3.3[c]
Urea N mg/dl	20.56[b]	22.43[c]

[a]Pre– and postpartum means for estradiol are high because they include the dramatic rise at parturition.
[b,c]Row Means Differ ($P < .05$)

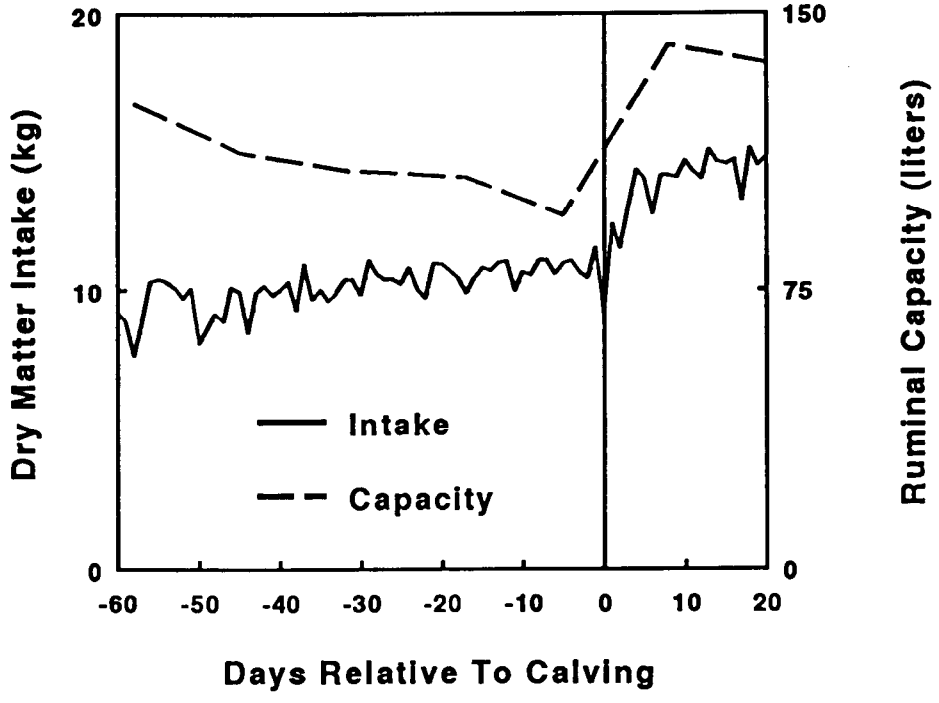

Figure 1. Changes in Capacity and Intake Around Calving

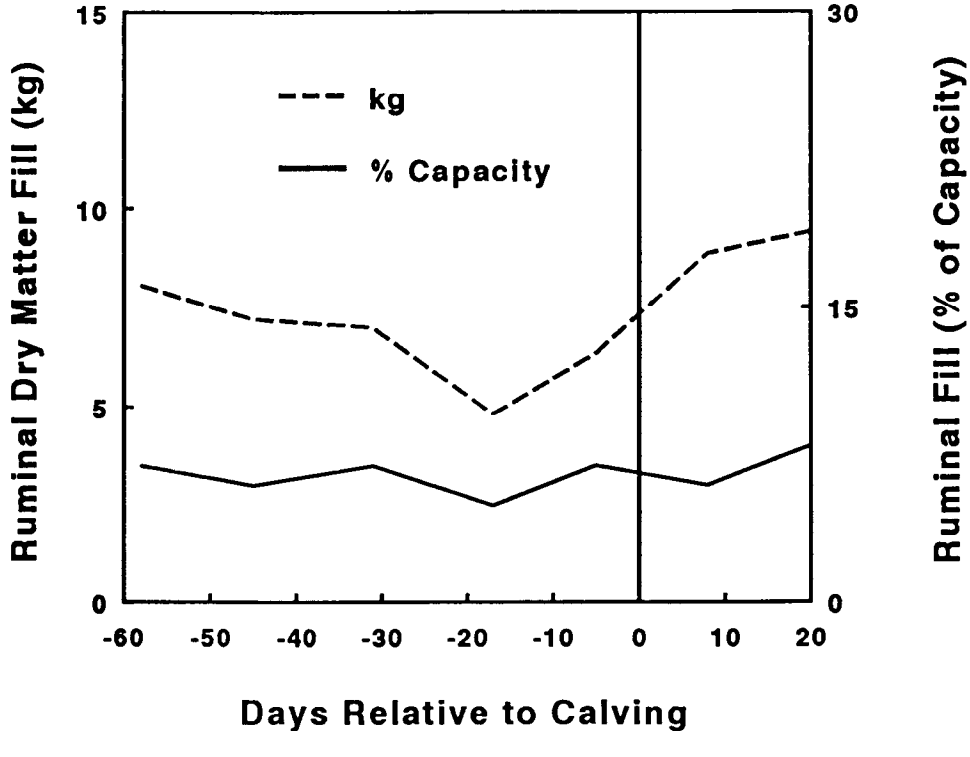

Figure 2. Changes in Ruminal Fill Around Calving

SUMMER ANNUAL FORAGES IN SOUTH CENTRAL KANSAS

W. F. Heer[1], D. A. Blasi[2], D. L. Fjell[3], J. P. Shroyer, and G. L. Kuhl

Summary

Six, summer annual forages and three forage sorghums were evaluated for forage yield and quality under south central Kansas dryland conditions. The sudans and forage sorghums produced similar amounts of dry matter per acre, and yields for these two forage types were significantly higher than for the pearl millet cultivars tested. Conversely, the pearl millets provided higher quality forage in terms of crude protein and acid detergent fiber levels. Droughty conditions severely limited forage yields. However, forage nitrate and prussic acid levels were all relatively low, indicating the utility of raising the cutter bar to avoid harvesting the lower stalks that can contain high nitrate concentrations.

(Key Words: Summer Annuals, Forage Sorghums, Yield, Forage Quality, Nitrate.)

Introduction

Summer annual forages offer Kansas livestock producers flexibility either as substitutes for perennial warm-season grasses in complementary forage grazing systems or as hedges for harvested forage during periods of low rainfall. Because summer annual types and cultivars have various growth characteristics, it is important that proper summer annual selection be based on intended use (grazing, haying, or silage purposes). This study compared the yield and nutritional quality of six summer annuals and three forage sorghums.

Experimental Procedures

Field plots were established on the South Central Kansas Experiment Field near Hutchinson during the summer of 1990. The plot area received a broadcast application of 75 pounds of nitrogen per acre as 46-0-0, which was incorporated to a depth of 2 to 4 inches with a field cultivator. Four replications of 5 by 30 ft plots were marked off and planted on June 12. A modified KEM plot drill with a belt cone metering device was used to seed the forages in randomly assigned plots at a rate of 15 pounds seed per acre in 8-inch rows.

Agronomic data collected for each plot included stage of maturity and plant height at harvest on August 8, 1990. The plots were harvested at a height of 5 to 7 inches with a Carter forage harvester. Forage from each variety plot was weighed, and two random subsamples were collected. One subsample was placed in a drying oven for determination of dry matter content and the other was sent to Peterson Laboratories in Hutchinson, Kansas for nutritional analysis.

Results and Discussion

The yield and forage quality results for the summer annuals are shown in Table 1. All cultivars were in the vegetative stage of growth at harvest, except for common sudan and Haygrazer which were at heading and later-boot stages, respectively. Forage yield and quality were severely affected by the abnormal weather conditions experienced during the 1990 growing

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season. June and early July had temperatures above normal (solid curves in Figure 1) for both highs and lows. The forages were then subjected to temperatures considerably lower than normal from mid-July through August. These temperature extremes occurred during a period of drought (long horizontal section of lower rough line in Figure 1).

The forage sorghums produced the largest amount of dry matter followed by the common sudan and Haygrazer, a sudan hybrid. The presence of a high proportion of stems makes these types of forages fit better in silage or greenchop harvesting systems. However, when planted in close rows (8-inch centers), ratio of stem to leaf decreases, and these cultivars lend themselves to grazing or hay production.

The pearl millet cultivars contained higher levels of crude protein ($P < 0.05$) than either the sudans or forage sorghums. Stage of maturity was certainly a factor, but previous Kansas work indicates that pearl millet tends to be a higher quality forage, presumably because of a higher leaf to stem ratio. This characteristic makes the pearl millets a logical choice for grazing and haying, providing they are cut at the proper stage of growth.

Despite the hot, dry environmental conditions discussed above, high nitrate and prussic acid accumulations were not observed in the samples analyzed. This may be partially attributed to the harvesting strategy employed of cutting the summer annuals at a height of 5 to 7 in. that left the potentially nitrate laden, lower portion of the plant stalks on the field.

The variation in yield and forage quality of the summer annuals examined in this study further emphasizes the importance of selecting the proper summer annual to plant based on intended use.

Table 1. Summer Annual Forage Yield and Nutritional Quality

Cultivar[1]	Plant Height Inches	Dry Matter %	DM Yield Ton/A	Crude Protein %	Nitrate (NO_3) ------ PPM ------	Prussic Acid	ADF[3] %
Horsepower PM	25.8	30.6	1.0	13.1	3025	90	30.3
Tifleaf PM	17.8	30.6	0.8	15.4	3050	109	28.8
GM 404 PM	26.8	29.0	0.9	13.0	3500	129	29.9
German Millet FM	19.0	32.8	1.4	11.1	2105	94	30.5
Common Sudan	50.3	39.3	2.1	6.8	1370	86	37.4
Haygrazer	51.3	29.8	2.0	9.0	1920	55	31.3
Silomaker FS	37.5	28.9	1.9	7.9	2460	82	31.7
Milk-A-Lot FS	32.5	36.7	1.8	9.2	1730	158	31.5
FS 555 FS	34.3	33.0	1.9	9.2	1960	159	31.5
Average	32.8	32.3	1.4	10.5	2347	106	31.4
L.S.D.[3]	3.9	NS	0.3	1.2	860	NS	1.6

[1]PM = Pearl millet; FM = Foxtail millet; Haygrazer = Sudan hybrid; and FS = Forage sorghum.
[2]ADF = Acid Detergent Fiber.
[3]Least significant difference ($P < .05$); NS = not significant.

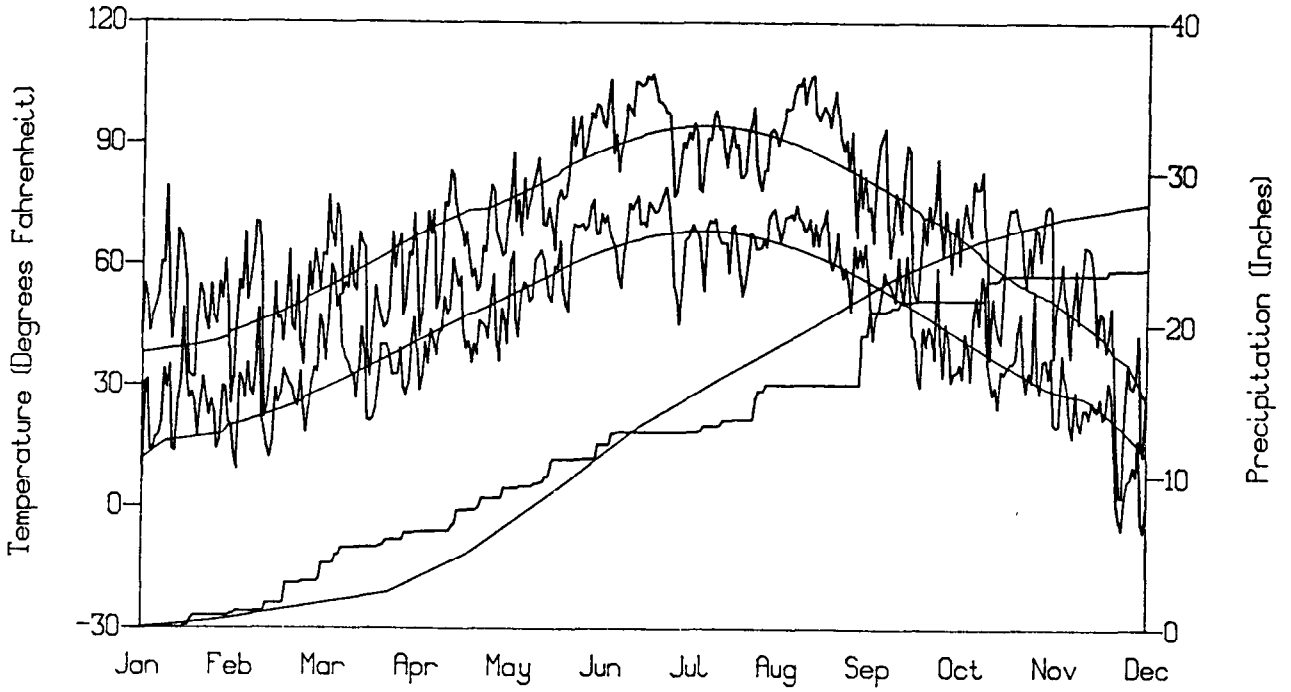

Figure 1. Graphical Weather Data Summary for Hutchinson, KS, 1990. K.S.U. Weather Data Library

EFFECTS OF HYBRID AND MATURITY AT HARVEST ON AGRONOMIC PERFORMANCE OF CORN FOR SILAGE[1]

R. Suazo, R. N. Sonon, L. Pfaff, J. T. Dickerson, and K. K. Bolsen

Summary

Twelve, commercial, corn hybrids were grown under irrigated conditions in 1990 and evaluated for agronomic and silage characteristics at three stages of maturities (1/2 milk line, black layer, and 7 days post-black layer). Time to mid-anthesis and mid-silk ranged from 62 to 68 and 65 to 70 days, respectively, and plant height ranged from 78 to 98 inches. Whole-plant dry matter (DM) content and whole-plant DM and grain yields for the 12 hybrids ranged from 23.6 to 53.7 %, 6.1 to 9.6 tons of DM per acre, and 60 to 170 bushels per acre, respectively, over the three maturities. Whole-plant DM content and grain yield increased ($P < .001$) with advancing maturity, whereas whole-plant DM yield peaked at the second maturity. These initial results indicate that hybrid and stage of maturity affect the agronomic characteristics of corn grown for silage.

(Key Words: Corn, Hybrid, Maturity, Silage.)

Introduction

Silage production in the United States is dominated by corn. Approximately 80 million tons of corn silage are produced annually, including about 1.5 million tons in Kansas. Typically, corn hybrids grown for silage have been selected for their high grain-yield potential and not necessarily for silage traits. A wide genetic diversity exists among corn hybrids for the agronomic characteristics that are considered important when choosing a hybrid for whole-plant silage in a beef cattle feeding program.

The objectives of this study were to evaluate agronomic and silage characteristics of 12 corn hybrids harvested for silage at three stages of maturity.

Experimental Procedures

Twelve, high grain-yielding, corn hybrids, representing a range of season lengths and genetic diversity were grown under irrigated conditions in 1990 near the Kansas State University campus, Manhattan. The hybrids were: Cargill (C) 6227, 7877, 8527, and 9427; DeKalb (DK) 649, 656, 689, and 711; and Pioneer (P) 3124, 3377, 3379, and 3389. The hybrids were planted on May 8, in plots 30 ft long that contained twelve, 30-inch rows. The hybrids were harvested at three stages of maturity, which were determined by the following kernel development stages: 1) one-half milk line, 2) black layer formation, and 3) 7 days post-black layer. All harvests occurred between August 15 and September 10. Agronomic data collected included days to mid-anthesis and mid-silk, plant height, whole-plant DM content, and whole-plant DM and grain yields. Two rows were harvested to determine whole-plant DM yield and one row to determine grain yield at each maturity. A single-row, precision, forage chopper was used to harvest the two silage rows, and all the ears from the third row were hand-picked. The forage was weighed and sampled; the ears were bagged, weighed, and frozen until shelled.

[1]Partial financial assistance was provided by Pioneer Hi-Bred International, Inc., North American Seed Division, Johnston, Iowa.

Results and Discussion

Shown in Table 1 are days to mid-silk, plant height, and dates of the ½ milk line and black layer harvests for the 12 hybrids. Days to mid-silk ranged from 65 to 70 days. Plant height ranged from 78 to 98 inches, with C 6227 and P 3124 being the shortest and C 7877, the tallest. Dates of first harvest occurred over 7, 5, and 5-day ranges for the Cargill, DeKalb, and Pioneer hybrids, respectively.

The effects of hybrid and maturity on whole-plant DM content and silage and grain yields are shown in Tables 2 and 3. No significant interactions occurred between hybrid and stage of maturity. Whole-plant DM content and whole-plant DM and grain yields were all significantly affected by stage of maturity.

The hybrid with the lowest average whole-plant DM content was C 9427 (34.2%) and P 3377 had the highest (41.2%). The hybrids with the highest grain yields were DK 649 at the first and third maturities and P 3377 at the second maturity. The lowest grain yields were for C 8527 at the first and C 6277 at the second and third maturities. DK 649 had the highest average whole-plant DM yield (8.4 tons/acre), and C 6227 had the lowest (6.7 tons/acre).

Whole-plant DM content and grain yield increased with advancing maturity, averaging 26.6 and 86, 38.4 and 135, and 47.7 % and 140 bushels per acre for ½ milk line, black layer, and 7 days post-black layer, respectively. Whole-plant DM yield was highest ($P < .001$) at the black layer stage and lowest at ½ milk line. Environmental factors decreased whole-plant DM yield at the last stage of maturity from 7.9 to 7.5 tons per acre compared to the black layer stage.

Table 1. Agronomic Characteristics for 12 Corn Hybrids

Hybrid	Days to mid-silk	Plant height, inches[1]	Harvest dates: ½ milk line stage	Harvest dates: Black layer stage
C 6227	65	78	August 20	September 1
C 7877	68	98	August 17	August 31
C 8527	68	92	August 15	August 31
C 9427	70	96	August 21	September 1
DK 649	69	90	August 20	September 3
DK 656	69	92	August 21	September 1
DK 689	70	88	August 22	September 3
DK 711	69	94	August 17	September 1
P 3124	70	78	August 21	September 3
P 3377	66	84	August 18	August 31
P 3379	67	90	August 18	September 3
P 3389	69	94	August 16	August 31

[1]Average of measurements taken at the three stages of maturity.

Table 2. Whole-plant Dry Matter Content and Silage and Grain Yields for 12 Corn Hybrids Harvested at Three Stages of Maturity

	Harvest stage								
	½ milk line			Black layer			7-day post-black layer		
Hybrids	Whole-plant DM and DM yield, %	T/A[1]	Grain yield, Bu/A[2]	Whole-plant DM and DM yield, %	T/A	Grain yield, Bu/A	Whole-plant DM and DM yield, %	T/A	Grain yield, Bu/A
C 6227	29.5	6.8	71	36.8	6.1	110	48.3	7.1	109
C 7877	25.2	6.4	75	36.9	7.4	143	49.5	7.1	137
C 8527	24.6	6.3	60	35.7	8.4	128	43.7	7.1	134
C 9427	25.8	6.6	82	32.4	8.2	124	44.3	7.9	121
DK 649	27.6	7.4	111	39.4	9.6	151	43.0	7.9	170
DK 656	28.5	6.5	90	37.7	7.8	125	45.1	6.9	147
DK 689	23.6	6.7	95	38.3	7.7	138	44.7	7.3	140
DK 711	24.9	6.1	93	37.0	8.9	127	47.8	6.9	147
P 3124	28.1	6.9	100	42.4	8.3	150	52.7	8.6	142
P 3377	28.4	6.9	91	42.3	7.3	160	53.7	7.2	148
P 3379	27.4	7.3	87	41.9	8.1	142	51.3	7.6	145
P 3389	26.1	6.3	81	40.9	7.8	127	48.8	7.5	147
LSD (P < .05)	2.1	1.0	12.9	3.8	1.4	29.4	4.6	1.1	19.8

[1]Tons per acre.
[2]Bushels per acre; adjusted to 14.5% moisture.

Table 3. Effect of Harvest Stage on Whole-plant DM Content and Silage and Grain Yields for 12 Corn Hybrids

	Harvest stage		
Item	½ milk line	Black layer	7-day post black layer
Whole-plant DM, %	26.6[c]	38.4[b]	47.7[a]
Whole-plant DM yield, tons/acre	6.7[c]	7.9[a]	7.5[b]
Grain yield, bushels/acre[1]	86[b]	135[a]	140[a]

[abc]Means in the same row with different superscripts differ significantly (P < .05).
[1]Adjusted to 14.5 % moisture.

EFFECTS OF MATURITY AT HARVEST AND CULTIVAR ON AGRONOMIC PERFORMANCE OF FORAGE SORGHUM AND THE NUTRITIVE VALUE OF SELECTED SORGHUM SILAGES

R. N. Sonon, R. Suazo, L. Pfaff,
J. T. Dickerson, and K. K. Bolsen

Summary

These studies examined the agronomic performance of 20 forage sorghum cultivars, each harvested at three stages of maturity in 1990. Whole-plant dry matter (DM) yields were highest at the late-dough stage of kernel maturity, whereas DM content and grain yields steadily increased as maturity advanced. A voluntary intake and digestion trial was conducted with 12 grain and forage sorghum silages harvested at the late-dough stage in 1989. The highest silage DM intakes and digestibilities were obtained with the high-grain yielding hybrids.

(Key Words: Forage Sorghum, Cultivar, Maturity, Intake, Digestibility.)

Introduction

Several earlier studies on the effects of stage of maturity showed that harvesting forage sorghums at the late-dough stage optimized silage yields and nutritive values. The objectives of this study were: 1) to document the effect of stage of maturity on agronomic performance over a wider range of forage sorghum phenotypes than was used in previous studies and 2) to continue to compare voluntary intake and DM digestibility of selected forage sorghum silages harvested in the late-dough stage.

Experimental Procedures

1990. Twenty forage sorghum cultivars were selected to represent a broad range of phenotypic characteristics and season lengths. All were grown under dryland conditions near the Kansas State University campus, Manhattan. The 12-row plots were planted on June 4, and each cultivar was randomly assigned to three replications. Rows were 25 ft long with a 30-inch spacing, and plots were thinned to uniform stands of 34,800 plants per acre. Cultivars were harvested at milk, late-dough, and hard-grain stages of kernel maturity. Agronomic data collected included days to half-bloom, plant height, lodging score, and whole-plant DM and grain yields. The first row in each plot was a border, and whole-plant DM yield for the first maturity stage was measured by harvesting the 2nd and 3rd rows with a precision chopper. All heads in the 4th row were clipped for grain yield determination. The plants in the 4th row were left standing to act as a border for the next harvest.

1989. A voluntary intake and digestion trial was conducted with 12 grain and forage sorghum silages produced in 1989. The cultivars were grown under dryland conditions and harvested in the late-dough stage. Three mature wethers were assigned to each silage in the two-period trial.

The farm-scale plots were similar to those described last year (Rep. of Prog. 592; pp. 110-113). However, dry soil conditions at planting on May 31 and subsequent very low rainfall until the second week in August (only 4.5 inches) produced thin and uneven stands, and one of the three replications for each cultivar was abandoned. Therefore, statistical analysis of the agronomic data shown in Table 4 is not reported, and the numerical values are presented for reference purposes only.

Results and Discussion

1990. Agronomic characteristics of the 20 forage sorghums are shown in Table 1. Blooming was delayed in all cultivars probably because of prolonged cool weather in the early part of the growing season. Time to half-bloom ranged from 64 to 83 days. Plant height varied greatly between cultivars and, as expected, the late-season hybrids were the tallest.

In the milk stage harvest, the only significant lodging occurred in three of the late-season hybrids (i.e., DeKalb FS25E, Garst 333, and SeedTec Hi-Energy II). However, several other cultivars lodged with advancing maturity (i.e., Funk's 102F, Golden Acres T-E Silomaker, Oro Kandy Kane, NC + 940, Pioneer 843 and 947, and Rox Orange). A very high wind on August 30th caused the initial lodging, which appeared to be more severe for the higher grain-yielding hybrids. Plant height did not show a direct relationship to lodging; some of the shorter cultivars had high lodging scores (i.e., Funk's 102F, Silomaker, and Rox Orange), whereas several of the taller sorghums had very low lodging scores (i.e., Atlas, DeKalb FS5 and FS25E, NC + NB305, and Pioneer 931).

The effects of cultivar and harvest stage on DM content and silage and grain yields of the 20 forage sorghums are presented in Tables 2 and 3. Very high rainfall (13.1 inches) from mid-July through August favored extended vegetative growth in the mid- and late-season hybrids, which resulted in higher whole-plant DM yields, particularly at the first two harvest stages, compared to the early-season sorghums. Limited rainfall during June and early-July resulted in relatively low whole-plant DM and grain yields for the early-season cultivars at the milk stage harvest (i.e., Buffalo Canex, Cargill 200F, Oro Kandy Kane, and Rox Orange). Whole-plant DM yields peaked at the late-dough stage; however, grain yields continued to increase and were highest at the hard-grain harvest. Eighteen of the 20 cultivars had their highest whole-plant DM yield at the late-dough stage and 14 of the 18 grain-producing sorghums had their highest grain yield at the hard-grain stage. The average harvest intervals were 12 days between the milk and late-dough and 13 days between the late-dough and hard-grain stages.

1989. Agronomic characteristics and results of the voluntary intake and digestion trial are shown in Table 4. Dry matter intake was positively associated with DM digestibility, and the highest digestibilities were obtained for the high grain-yielding cultivars. Six of the 10 grain-producing forage sorghums had not reached the late-dough stage at the first frost on September 24. The non-heading forage sorghum (Funk's G 1990) showed the lowest DM intake and digestibility, which is consistent with previous results for this cultivar.

1989 vs. 1990. Presented in Table 5 are minimum, maximum, and mean values for the agronomic characteristics of the 10 forage sorghum cultivars that were included in both the 1989 and 1990 late-dough stage harvests. Agronomic measurements were dramatically reduced in the 1989 growing season compared to 1990 (i.e., plant height and silage and grain yields).

Table 1. Agronomic Characteristics of 20 Forage Sorghum Cultivars, 1990

Cultivar[1]	Days to half-bloom[2]	Plant height,[2] inches	Date of the milk stage harvest	Lodging scores, %		
				Milk stage	Late-dough stage	Hard-grain stage
AgriPro 1020F	79	75	Sept 6	-	1	12
Atlas	75	122	Sept 4	-	-	1
Buffalo Canex	64	109	Aug 26	-	-	-
Cargill 200F	67	108	Aug 26	-	-	1
Cargill 466	82	102	Sept 11	5	3	57
Cargill Morcane	-	104	Aug 29	-	-	-
DeKalb FS5	72	122	Sept 3	-	5	8
DeKalb FS25E	83	127	Sept 11	12	18	10
Funk's 102F	80	95	Sept 8	4	30	49
Garst 333	81	110	Sept 7	27	58	79
GA T-E Silomaker	80	95	Sept 7	4	13	74
NC + NB305	69	118	Aug 28	-	4	2
NC + 940	69	124	Aug 31	-	14	18
NK 300	79	78	Sept 6	-	3	11
Oro Kandy Kane	65	104	Aug 28	-	18	22
Pioneer 843	74	126	Sept 3	2	13	21
Pioneer 931	-	172	Sept 11	1	-	3
Pioneer 947	73	117	Sept 3	-	54	76
Rox Orange	65	95	Aug 26	-	45	53
ST Hi-Energy II	80	122	Sept 7	60	28	66
Average	74.3	111.3	Sept 3	6	15	28
LSD ($P < .05$)[3]	--	4.2	--	--	--	--

[1]GA = Golden Acres; NK = Northrup King; ST = Seed Tec.
[2]Average of measurements taken at the first two stages of maturity.
[3]Least significant difference.

Table 2. Dry Matter Content and Silage and Grain Yields of 20 Forage Sorghum Cultivars Harvested at Three Stages of Maturity, 1990

	Harvest stage								
	Milk			Late-dough			Hard-grain		
Cultivar	Whole-plant DM and DM yield, %	T/A[1]	Grain yield, Bu/A[2]	Whole-plant DM and DM yield, %	T/A	Grain yield, Bu/A	Whole-plant DM and DM yield, %	T/A	Grain yield, Bu/A
AgriPro 1020F	25.3	5.5	66	31.0	6.8	114	38.7	5.9	119
Atlas	25.3	6.0	41	27.8	7.3	58	28.5	5.7	65
Buffalo Canex	25.1	5.3	17	28.5	6.1	47	31.1	5.7	72
Cargill 200F	28.3	4.7	16	37.6	5.8	72	42.9	6.1	89
Cargill 466	22.6	6.8	61	26.2	7.8	124	32.7	6.6	121
Cargill Morcane	23.7	4.3	-	26.4	5.8	-	27.8	6.1	-
DeKalb FS5	24.8	5.4	58	30.2	7.9	87	34.0	7.2	82
DeKalb FS25E	25.1	7.5	49	27.1	8.2	82	29.9	6.2	107
Funk's 102F	22.4	6.0	54	28.2	7.8	106	33.8	5.9	126
Garst 333	27.3	5.8	39	32.8	8.4	110	37.4	6.3	114
GA T-E Silomaker	24.4	6.4	46	29.0	7.8	96	41.1	6.5	151
NC + NB305	23.1	5.4	23	29.3	7.1	55	30.8	6.3	65
NC + 940	24.7	5.8	40	29.5	7.2	85	31.7	6.3	97
NK 300	24.4	5.8	60	33.9	7.4	105	35.9	6.0	117
Oro Kandy Kane	24.1	4.9	24	30.4	6.9	93	32.7	5.4	92
Pioneer 843	31.4	5.1	45	40.0	8.0	74	38.8	5.6	72
Pioneer 931	32.7	8.3	-	34.3	6.3	-	38.3	6.1	-
Pioneer 947	30.8	4.6	48	43.0	8.3	119	45.7	6.3	133
Rox Orange	22.0	4.5	18	27.2	5.7	83	33.0	5.4	93
ST Hi-Energy II	25.1	7.5	51	24.5	7.2	96	29.5	6.1	112
LSD[3] (P < .05)	--	1.0	13.4	--	1.1	27.0	--	.8	23.8

[1]Tons per acre.
[2]Bushels per acre; adjusted to 14.5% moisture.
[3]Least significant difference.

Table 3. Effect of Harvest Stage on Dry Matter Content and Silage and Grain Yields of 20 Forage Sorghum Cultivars, 1990

	Harvest stage		
Item	Milk	Late-dough	Hard-grain
Whole-plant DM, %	25.6[c]	30.8[b]	34.7[a]
Whole-plant DM yield, tons/acre	5.8[b]	7.2[a]	6.1[b]
Grain yield, bushels/acre[1,2]	42[c]	90[b]	102[a]

[abc]Means in the same row with different superscripts differ significantly (P < .05).
[1]Average of the 18 grain-producing cultivars.
[2]Adjusted to 14.5 % moisture.

Table 4. Agronomic Characteristics, Dry Matter Content, Voluntary Intake, and Digestibility of 12 Sorghum Silages, 1989

						Ration[3]	
Cultivar	Days to half-bloom	Plant height, inches	Silage DM, %	Whole-plant DM yield, T/A[1]	Grain yield, Bu/A[2]	DM intake, g/MBW[4]	DM digestibility, %
Grain sorghum							
DeKalb 42Y	66	37	37.6	3.9	92*	71.0	61.2
Forage sorghum							
DeKalb FS5	73	73	30.4	6.0	98*	69.9	56.8
DeKalb FS25E	103	91	27.8	6.2	34***	67.0	55.7
Funk's 102F	92	76	30.2	5.7	60**	72.8	58.2
Funk's G 1990	--	114	25.6	5.8	--	57.6	55.2
Garst 333	96	77	28.6	5.5	34***	63.7	57.0
GA T-E Silomaker	92	70	29.6	5.8	46**	62.5	52.7
NK 300	89	58	30.9	5.5	77**	67.2	58.9
Oro Kandy Kane	67	61	33.3	4.5	77*	77.5	59.2
Pioneer 947	75	73	33.3	5.6	91*	67.2	58.2
Rox Orange	67	57	31.6	3.7	74*	66.2	55.8
ST Hi-Energy II	92	89	28.6	6.2	43**	63.6	55.6
LSD (P < .05)	--	--	--	--	--	11.4	5.0

[1]Tons per acre.

[2]Bushels per acre; adjusted to 14.5% moisture.

[3]Ration = 90% silage and 10% supplement on a DM basis.

[4]MBW = metabolic body wt ($kg^{.75}$).

*Cultivars that were between the late-dough and hard-grain stages at the first frost on Sept 24.

**Hybrids that were in the mid-to-late milk stage at the first frost.

***Hybrids that were in the early-milk stage at the first frost.

Table 5. Minimum, Maximum, and Mean for the Agronomic Characteristics of 10 Forage Sorghum Cultivars Compared in Both 1989 and 1990

	Minimum		Maximum		Mean	
Item	1989	1990	1989	1990	1989	1990
Days to half-bloom	67	65	103	83	85	76
Plant height, inches	57	78	91	127	84	107
Lodging score, %	0	3	9	58	3	27
Silage yield, tons of DM/acre	3.7	5.7	6.2	8.4	5.47	7.56
Grain yield, bu/acre[1]	34	82	98	119	63	98
Whole-plant DM, %	27.8	24.5	33.3	43.0	30.4	30.6

[1]Adjusted to 14.5% moisture.

TOP SPOILAGE LOSSES IN HORIZONTAL SILOS IN WESTERN KANSAS[1]

J. T. Dickerson, G. Ashbell[2], L. Pfaff, K. K. Bolsen, B. E. Brent, J. E. Bradford, and R. L. Smith[3]

Summary

The top 3 feet from 30 horizontal silos was sampled at three depths to determine top spoilage losses, using ash content as an internal marker. When compared to face samples, corn and forage sorghum silages exhibited similar additional organic matter (OM) losses in the top 18 inches. In the top 18 inches, covering silage reduced spoilage losses of OM from 41 to 27 percentage units compared to uncovered counterparts. Covering corn silage reduced spoilage losses of OM from 49 to 31 and 9 to 1 percentage units in the top and second 18 inches, respectively. Similar reductions in OM losses from covering were observed in the forage sorghum silages. Although spoilage losses observed in covered silages appear high, covering silage stored in horizontal silos greatly reduced the estimated storage losses in the top 3 feet.

(Key Words: Survey, Top Spoilage, Silage, Horizontal Silos.)

Introduction

In the High Plains, horizontal silos are preferred to store large amounts of silage. By design, these structures allow large percentages of the silage mass to be exposed to environmental and climatic effects. Excessive dry matter (DM) and nutrient loss can occur in the top layer and greatly decrease storage efficiency. In a silo with 900 tons storage capacity (100 ft long × 40 ft wide × 10 ft deep), up to 25% of the original silage mass is within the top 3 feet. The conventional method of protecting the top layer is covering with plastic sheeting and tires. However, to our knowledge, the extent of top spoilage losses has not been documented under farm-scale conditions.

The objective of this survey was to determine the extent of the losses associated with the top layer of horizontal silos by using ash content as an internal marker.

Experimental Procedures

In January of 1990, the top 3 ft from 30 horizontal (bunker and trench) silos was sampled, each at three locations across the width of the silo. Sample depths were: 1) 0 to 18 in from the top (depth 1), 2) 19 to 36 in (depth 2), and 3) a representative silage sample from the face, at least 6 ft from the top (face). Depth 1 was sampled using an 8 in diameter × 18 in long PVC pipe with a serrated end. Depth 2 was sampled using a silage corer, powered by an electric drill. Face samples were collected by hand in locations where there was no observable spoilage (12 to 18 in into the silage face). The silage samples were then frozen

[1]Appreciation is expressed to Mr. Les Chyba, Scott Pro, Inc., Scott City for assistance in collecting the survey data presented in this report.

[2]Visiting researcher from The Volcani Center, Bet Dagan, Israel.

[3]Servi-Tech Inc., Dodge City, Kansas.

[4]The silos were located in the Dodge City, Scott City, and Colby areas of Western Kansas.

and transported to Manhattan for analyses of pH and DM and ash contents.

Results and Discussion

Illustrated in Figure 1 is the relationship between ash content of a sample and estimated spoilage loss of organic matter (OM). Spoilage loss is defined as the OM loss over and above the loss undergone by the presumably well-preserved "face" sample. The relationship is based on the assumption that, as spoilage occurs, OM disappears but the absolute amount of ash remains constant. The graph assumes that the face silage is 8% ash (DM basis), thus 92% organic matter. The relationship between ash in a silage sample and spoilage loss of OM can be expressed as:

$$1 - [(AF \times OMS)/(AS \times OMF)] \times 100$$

Where:

AF = percent ash at the face.
OMF = percent organic matter at the face.
AS = percent ash in the top sample.
OMS = percent organic matter in the top sample.

Regardless of face ash content, small increases in ash content of deteriorated silage represent large percentage unit increases in OM loss.

Shown in Table 1 are the effects of crop and covering on additional percentage unit spoilage losses of OM. There was no difference between crops at depth 1; corn and forage sorghum silages both exhibited an additional 38 percentage unit spoilage loss of OM. However, corn silages tended to have greater OM losses at depth 2 than forage sorghum silages (7 vs 3 percentage units). Covering silage reduced spoilage losses of OM at depth 1 from 41 to 27 percentage units compared to silage with no cover. Similarly, losses at depth 2 were reduced from an additional 6 percentage units down to 2 when silages were covered. Covering corn silage reduced OM losses from 49 to 31 and 9 to 1 percentage units at depths 1 and 2, respectively, when compared to uncovered silages. Similar trends were observed in covered forage sorghum silages.

Shown in Table 2 are the effects of covering and sample location on pH, DM and ash contents, and estimated spoilage losses of OM for 10 of the 30 corn and forage sorghum silages. For both crops, face silages had low pH values (3.56 to 3.92) and acceptable DM contents (25.0 to 38.9%), indicating satisfactory preservation. The pHs of covered silages were not greatly affected by depth, although depth 1 silages had slightly higher values. The pH values of uncovered silages at depth 1 were very high (4.96 to 7.50), whereas pHs at depth 2 approached those of the face silages. Also, ash content was higher in the uncovered silages at depth 1, ranging from 11.7 to 23.9 percent. Ash content at depth 2, although higher, approached that found in the face samples. Covering reduced increases in ash content compared to uncovered silages at both depths. Face ash content ranged from 5.7 to 10.5 and 6.6 to 11.6% for corn and forage sorghum, respectively. Because of this variability, estimates of spoilage losses of OM were made only within individual silos. In both crops, uncovered silages exhibited higher OM losses (ranging from 37.1 to 73.4 percentage units) compared to their covered counterparts (ranging from 13.3 to 42.4 percentage units). However, uncovered corn silages tended to have higher OM losses than uncovered forage sorghum silages. As expected, estimates of spoilage loss of OM were lower at depth 2, regardless of crop or covering treatment.

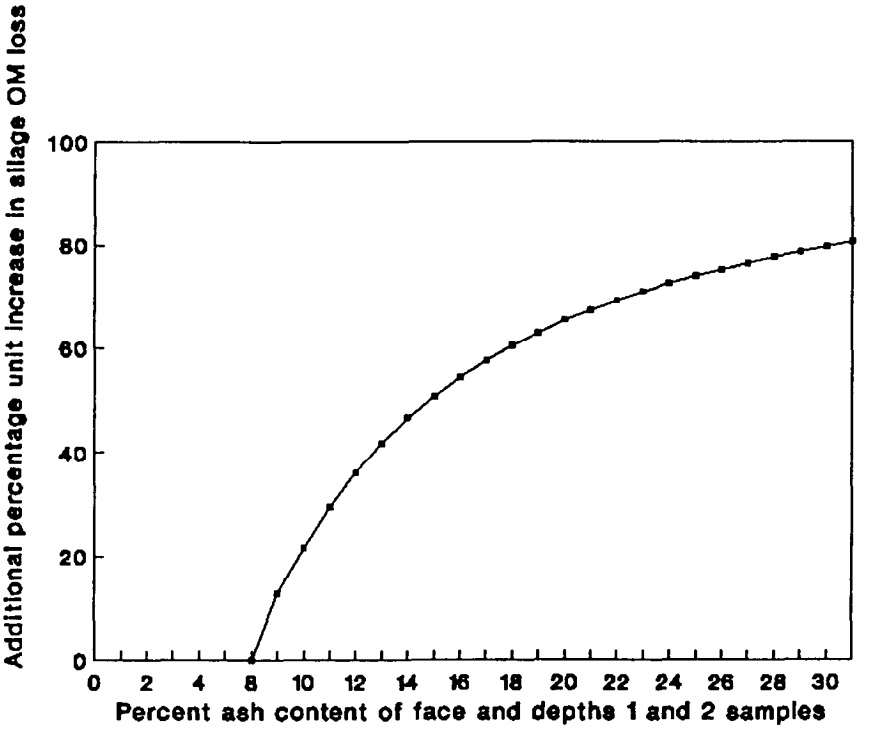

Figure 1. The Relationships between Ash Content of Silages and Organic Matter Loss above that Already Undergone by Well-preserved (Face) Silage

Table 1. Effects of Crop and Covering Treatment on Additional Spoilage Losses of OM at Depths 1 and 2 Compared to the Face Sample

Crop and treatment	Depth 1 vs face	Depth 2 vs face
Crop	---- Percentage unit spoilage OM loss ----	
All crops (30)[2]	39	6
Whole-plant corn (14)	38	7
Forage sorghum (13)	38	3
Treatment		
Covered (5)	27	2
Uncovered (22)	41	6
Corn		
Uncovered (12)	49	9
Covered (2)	31	1
Forage sorghum		
Uncovered (10)	42	3
Covered (3)	23	2

[1]Number of silos per crop or treatment in parentheses.
[2]Includes data from uncovered alfalfa, wheat, and oat silages.

Table 2. Effects of Covering Treatment and Location on pH, DM and Ash Contents, and Estimated Spoilage Losses of OM of 10 Representative Corn and Forage Sorghum Silages

Crop and treatment	Location	Silage pH	Silage DM, %	Silage Ash, %	Estimated OM loss[1]
Corn					
Uncovered	Depth 1	5.95	37.3	23.9	73.4
	Depth 2	3.66	38.7	10.2	26.6
	Face	3.67	34.0	7.7	--
Uncovered	Depth 1	5.33	37.0	11.7	51.8
	Depth 2	3.74	34.0	6.2	3.4
	Face	3.73	37.0	6.0	--
Uncovered	Depth 1	4.96	34.8	17.8	64.6
	Depth 2	3.62	38.6	8.6	18.5
	Face	3.66	38.7	7.2	--
Covered	Depth 1	4.55	33.4	13.4	24.2
	Depth 2	3.65	34.1	10.6	1.0
	Face	3.61	25.0	10.5	--
Covered	Depth 1	4.25	23.0	9.5	42.4
	Depth 2	3.53	33.9	5.8	1.8
	Face	3.56	33.6	5.7	--
Forage sorghum					
Uncovered	Depth 1	7.50	45.5	13.6	37.1
	Depth 2	3.78	35.9	9.1	0
	Face	3.76	33.7	9.1	--
Uncovered	Depth 1	7.47	24.8	20.2	48.2
	Depth 2	4.18	26.1	12.5	8.1
	Face	3.92	22.3	11.6	--
Uncovered	Depth 1	6.93	45.7	15.5	45.4
	Depth 2	3.91	41.8	9.6	5.7
	Face	3.79	38.9	9.1	--
Covered	Depth 1	3.84	26.8	9.7	13.3
	Depth 2	3.71	29.9	8.8	3.7
	Face	3.62	29.1	8.5	--
Covered	Depth 1	3.81	25.3	10.0	36.4
	Depth 2	3.56	34.4	6.7	1.6
	Face	3.64	28.4	6.6	--

[1]See equation on page 71.

RATE AND EXTENT OF TOP SPOILAGE LOSSES OF ALFALFA SILAGE STORED IN HORIZONTAL SILOS[1]

J. T. Dickerson, Y. Niwa[2], K. K. Bolsen, B. E. Brent, C. Lin, and J. E. Bradford

Summary

Effects of covering, time, and depth from the surface on the rate and extent of top spoilage losses in alfalfa silages stored in horizontal silos were studied under pilot- and farm-scale conditions. Covering silages increased silage DM and nutrient recoveries, regardless of time or depth from the original surface, when compared to uncovered counterparts. Treatment × location × time interactions ($P < .001$) were observed for pH, lactic acid, and DM recovery in uncovered silages. By week 2 post-ensiling, significant deterioration had occurred in the top foot of uncovered silages, as evidenced by higher pH (7.36) and lower lactic acid (2.1% of the silage DM) and DM recoveries (85.6% of the DM ensiled). After week 4 post-ensiling, significant deterioration had occurred in the second foot from the surface, and it continued into the third foot after week 7. These data indicate that protecting the silage stored in the top 3 ft of horizontal silos immediately after filling should greatly increase storage efficiency.

(Key Words: Silage, Alfalfa, Top Spoilage, Horizontal Silos.)

Introduction

Horizontal (bunker and trench) silos are economically attractive for storing large amounts of ensiled feeds, but by design, they allow large percentages of the silage mass to be exposed to the environment. Because these structures are relatively shallow, over 20% of the original ensiled volume can be within the top 3 ft. Past research with corn has shown dry matter (DM) losses of up to 40% in the top 20 inches of silage. To date, controlled experiments under simulated farm-scale conditions have not adequately characterized the rate and extent of DM losses occurring in this top layer. Such data are necessary to assess the economic feasibility of covering silage in horizontal silos.

Our objectives were to determine the extent of losses in the top 3 ft of farm-scale horizontal silos and to develop a laboratory model to study the rate and extent of those losses.

Experimental Procedures

Pilot-scale silos. First-cutting alfalfa (10% bloom) was packed to equal densities (15 lb of DM/ft^3) into 16, 55-gallon drums. Each drum was divided horizontally with plastic netting into thirds to partition the fresh material at 12 and 24 inches below the original surface. A perforated 1.0 in. PVC pipe was placed at the bottom of each drum and connected through an air-lock to drain off percolated water. Drums were either covered with .4 mm plastic sheeting or left uncovered. Pilot silos were stored outside and opened at 2, 4, 7, and 12 weeks post-ensiling (two silos/treatment/opening time). Samples were analyzed for pH, lactic acid, acetic acid, and DM content. The data were analyzed as a split-plot design with duplicate drums and time periods being whole-plot factors, and location (depth) within drums denoting the sub-plot units.

[1]Financial assistance was provided by Kemin Industries Inc., Des Moines, Iowa and Mr. Richard Porter, Reading, Kansas.

[2]Visiting researcher from Nihon University, Fujisawa City, Japan.

Farm-scale silos. Second-cutting alfalfa (10% bloom) was swathed, wilted, chopped, and packed in two, 16 ft long × 13.5 ft wide × 4 ft deep, bunker silos. During filling, nylon net bags, each containing 6.5 lb of fresh material, were placed 10, 20, and 30 inches from the top of the original silage mass. Thermocouples were placed at each location, and temperatures were recorded daily for the first 30 days. The silos contained similar amounts of fresh material and were packed by a tractor to densities that were similar to those in the pilot-scale silos. Treatments were the same as in the pilot-scale trial. Bunkers were emptied at 12 weeks post-ensiling. Nylon bags were re-covered, and silage was weighed, mixed, sampled, and analyzed as above.

Results and Discussion

Silages stored in covered pilot-scale silos were well preserved and of high quality, whereas uncovered silages were of poor quality and deteriorated steadily during storage. Treatment × location × time interactions ($P < .001$) were observed for pH, lactic acid content, and DM recovery. Figure 1 shows the effects of covering and time post-ensiling on silage pH at the three depths from the original surface. The silage pH in covered drums was below 5.0 at all four opening times, regardless of location. In contrast, in the top 12 inches, uncovered silages exhibited a dramatically higher pH (7.36) by week 2 post-ensiling. Deterioration progressed as deep as 24 inches in uncovered silages by week 7, and by week 12, pH of silage was similar below 24 inches and at 12 to 24 inches (6.15 and 6.14).

Illustrated in Figure 2 are the effects of covering and time post-ensiling on silage lactic acid content at the three depths from the original surface. Lactic acid content of silage stored in covered drums was not affected by time or location; 7.3, 8.2, and 8.3% of the silage DM at the 0 to 12, 12 to 24, and 24 to 36 inch depths, respectively, at week 12 post-ensiling. Lactic acid content of a silage represents a balance between lactic acid production and utilization. There was insufficient lactic acid to preserve silage in the top 12 inches of uncovered silages at all of the opening periods. Initially in the uncovered silages, adequate amounts of lactic acid were present below 12 inches. However, by week 12, silage lactic acid content had markedly declined, whereas acetic acid had increased (9.9, 10.6, and 10.0% of the silage DM at the 0 to 12, 12 to 24, and 24 to 36 inch depths, respectively). Silage acetic acid and ammonia-nitrogen contents were higher ($P < .05$) when silage was stored in uncovered silos, regardless of location or storage period. Silage made in uncovered silos possessed characteristics commonly observed in poorly preserved material.

Shown in Figure 3 are the effects of covering and time post-ensiling on silage DM recovery at the three depths from the original surface. Silages stored in covered drums exhibited high DM recoveries, regardless of time or location, averaging 92.3, 91.3, and 91.3% of the DM ensiled at the three depths at week 12. As expected, DM recoveries were compromised in uncovered silages, regardless of depth. Silage DM recovery decreased linearly at each opening date for silage above 12 inches and at week 4 in silage stored 12 to 24 inches from the original surface. The DM recoveries of silage stored in uncovered silos at week 12 were 33.9, 59.2, and 64.2% of the DM ensiled at the 0 to 12, 12 to 24, and 24 to 36 inch depths, respectively.

Shown in Table 1 are the effects of covering and depth from the surface on silage DM recovery, pH, lactic acid, acetic acid, and temperature in the farm-scale silos. The covered silage was of excellent quality and similar to silage made in the covered pilot-scale silos. Silage from the uncovered farm-scale silo exhibited low DM recovery (22.2% of the DM ensiled), high pH (9.59), and low lactic acid content (0.1% of the silage DM) 10 inches from the surface at 12 weeks post-ensiling. Below 20 inches from the surface, silage DM recovery and pH approached the levels in covered silage. Silage temperature at 30 days post-ensiling was significantly higher at all depths in the

uncovered farm-scale silo when compared to silage that was covered.

Pilot-scale silos successfully replicated most conditions in the farm-scale silos. However, temperatures in the farm-scale silos were higher, probably representing greater heat dissipation from the smaller, less insulated, pilot-scale silos.

Table 1. Effects of Covering Treatment and Depth from the Surface on DM Recovery, pH, Lactic Acid, Acetic Acid, and Temperature of Alfalfa Silage Stored in Farm-scale Horizontal Silos at 12 Weeks Post-ensiling

Treatment	Depth from surface, inches	DM recovery[1]	pH	Lactic acid[2]	Acetic acid[2]	Lactic: acetic	Temp,[3] °F	
Uncovered	10	22.2	9.58	.1	---	---	97	(120)
	20	76.6	5.35	3.1	2.0	1.6	127	(122)
	30	85.4	4.55	2.6	2.2	1.2	82	(106)
Covered	10	92.8	4.88	2.4	1.3	1.8	72	(75)
	20	98.4	4.49	7.5	3.6	2.1	77	(82)
	30	94.3	4.50	8.0	4.8	1.7	72	(86)

[1]Expressed as a % of the DM ensiled.
[2]Expressed as a % of the silage dry matter.
[3]Temperature at 30 days post-ensiling and maximum temperature from 0 to 30 days in parenthesis.

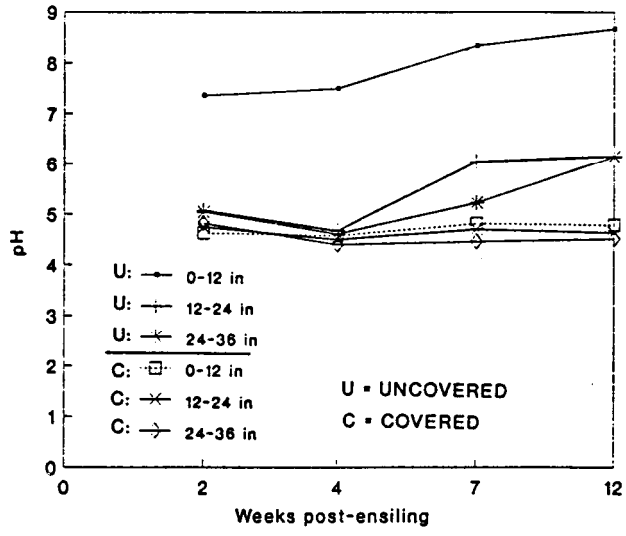

Figure 1. Effects of Covering and Time Post-ensiling on Silage pH at the Three Depths from the Original Surface in Pilot-scale Silos

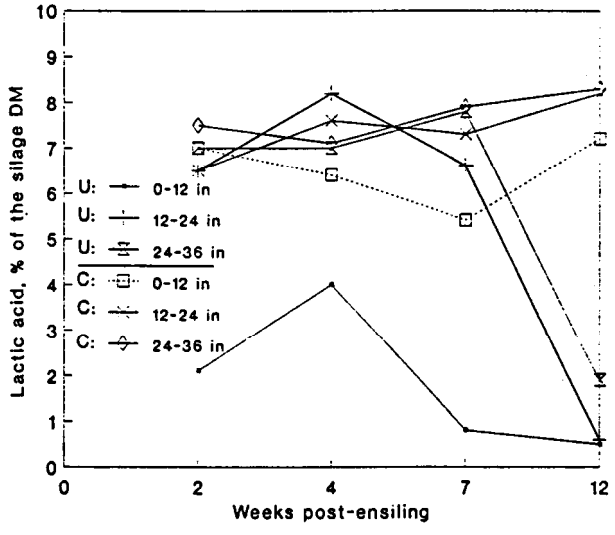

Figure 2. Effects of Covering and Time Post-ensiling on Silage Lactic Acid Content at the Three Depths from the Original Surface in Pilot-scale Silos

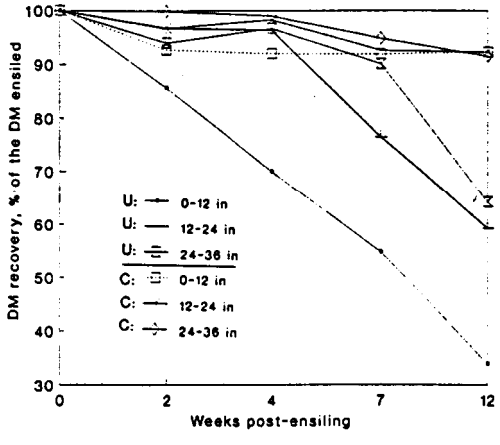

Figure 3. Effects of Covering and Time Post-ensiling on Silage DM Recovery at the Three Depths from the Original Surface in Pilot-scale Silos

EFFECTS OF CROP SPECIES ON INDIGENOUS MICROFLORA AND OF SILAGE ADDITIVES ON THE MICROBIAL SUCCESSION DURING THE ENSILING PROCESS[1,2]

C. Lin, R. A. Hart, K. K. Bolsen, J. T. Dickerson, and B. E. Brent

Summary

This study considered the effects of crop species (alfalfa vs. corn) and silage additives on six categories of indigenous microorganisms (those naturally occurring on the crop) important to silage fermentation, and on the microbial succession during the ensiling process. The numbers of streptococci, Enterobacteriaceae, yeasts and molds, lactate-using yeasts, and carbohydrate-fermenting clostridial spores were higher on corn than on alfalfa. The lactic acid bacteria (LAB) comprised less than 2% of the total microbial populations on both crops.

Alfalfa treated with Biomate® inoculant and the combination of dextrose and Biomate showed higher LAB counts than the control and dextrose treatments at 1 day post-ensiling. Adding dextrose accelerated multiplication of LAB in the ensiled alfalfa. Adding 1174® inoculant to corn silages did not affect the microbial succession during the ensiling process. Development of Enterobacteriaceae, yeasts and molds, lactate-using yeasts, and clostridia on either crop during ensiling was not influenced by the additives.

(Key Words: Epiphytic Microflora, Alfalfa, Corn, Additive, Silage.)

Introduction

Indigenous (epithytic) microorganisms are important in silage preservation. Not only are they responsible for silage fermentation, but they influence the effectiveness of silage additives. The microflora involved in ensiling comprises mainly lactic acid bacteria (LAB), but 'bad' organisms, i.e., Enterobacteriaceae, clostridia, yeasts, and molds can also be present. Their frequencies on silage crops are quite variable and are affected by crop species, variety/hybrid, maturity stage, climate or soil, and mowing, field-wilting, or chopping processes. Dramatic changes in numbers and proportions of the epiphytic microflora also occur once the chopped forage is ensiled.

Stimulating silage fermentation by adding bacterial cultures has become a common practice, because these products are safe to handle and help establish homolactic fermentations (fermentations producing only lactic acid). This study investigated the effect of additives on microbial succession on alfalfa and corn during the ensiling process. The factors influencing the epiphytic microorganisms on alfalfa and corn in this study were reported last year (Rep. of Prog. 592; pp. 118-122).

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[1]Biomate® was provided by Chr. Hansen's Bio Systems, Milwaukee, Wisconsin and contains Lactobacillus plantarum and Pediococcus cerevisiae.

[2]1174® was provided by Pioneer Hi-Bred International, Inc., Des Moines, Iowa and contains Lactobacillus plantarum (multiple strains) and Streptococcus faecium.

Experimental Procedures

A second-year stand of Cody alfalfa was examined at 2nd, 3rd, 4th, and 5th cuttings and at late-bud, 10% bloom, and 50% bloom within each cutting. Three Pioneer corn hybrids (3377, 3379, and 3389) were grown under irrigation and were ensiled at the two-thirds milk line of kernel maturity.

Chopped alfalfa (2nd and 4th cuttings) received no additive (control) or three treatments: dextrose (applied at 2% of the crop dry matter), Biomate inoculant (to supply 1.5×10^5 colony-forming units (CFU)/g of fresh crop), and a combination of dextrose and Biomate. The corn was treated with 1174 inoculant to supply 1.5×10^5 CFU/g of fresh crop. Treated crops were ensiled in 4 × 14 in. laboratory silos. Three replicate silos were opened at various times up to 120 days post-ensiling.

Weather data were recorded on sampling days. By use of appropriate selective media, lactobacilli, pediococci, and leuconostoc (LPL); streptococci (Str); Enterobacteriaceae (Ent); yeasts and molds (YM); lactate-using yeasts (LUY); and lactate-fermenting clostridial spores (Clo) were enumerated. The LAB were calculated as the sum of LPL and streptococci. Other details of the procedures used were published in Rep. of Prog. 592.

Results and Discussion

Microorganism counts were higher on the standing corn than alfalfa ($P < .05$) (Figure 1). Enterobacteriaceae were predominant on alfalfa (10^6 CFU/g); yeasts and molds and Enterobacteriaceae were predominant on corn (10^6 CFU/g). The LAB comprised less than 2 percent of the total microbial population on both alfalfa and corn; the main LAB were streptococci. No clostridial spores were found on the 12 standing alfalfas, but they were present on two of the corn hybrids. The appearance of clostridial spores on the corn hybrids might be attributed to heavy rainfall prior to harvest.

Cutting number did not influence the epiphytic microflora ($P > .05$) on alfalfa, although the 3rd and 4th cuttings had numerically higher populations of LAB than the 2nd and 5th. Wilting of alfalfa decreased LAB counts slightly ($P > .05$) but increased Enterobacteriaceae ($P < .05$), yeasts and molds, and clostridial spores ($P > .05$). Once the forage crops went through the chopper, a dramatic increase ($P < .05$) occurred in LAB and Enterobacteriaceae on both alfalfa and corn. The 'chopping inoculation' phenomenon has been observed by others and has been an enigma to researchers. It has been attributed to harvester contamination, microbial growth, or both. However, recent studies have shown these earlier explanations to be neither adequate nor true. A new "somnicell" hypothesis, in which bacteria are assumed viable but in a non-culturable stage on standing crops, is proposed but still needs more investigation.

After the alfalfa was ensiled, LAB quickly proliferated and dominated the silage at one day post-ensiling (Figures 2 and 3). Note that the y axis is logarithmic, so differences that appear small can be large. Silage treated with Biomate and the combination of dextrose and Biomate showed higher LAB counts than either control or dextrose treatments ($P < .05$) at 1 day post-ensiling. Adding dextrose resulted in faster LAB growth up to 3 days post-ensiling, demonstrating the limiting nature of water soluble carbohydrates in alfalfa. The LAB counts were similar between treatments after 7 days post-ensiling, except that the Biomate-treated silage maintained a high level of LPL at the end of ensiling. Enterobacteriaceae and yeasts and molds decreased continuously as ensiling progressed (Figures 4 and 5). Both dextrose and combination treatments accelerated this decrease. Clostridia remained at very low levels and were not influenced by the treatments at any points during the ensiling process.

The 1174 inoculant did not affect microbial succession during the ensiling process of corn (P>.05) (Figure 6). Epiphytic LAB reached 10^7/g at ensiling, which was 60 times that provided by the 1174 inoculant. The LAB became predominant at 6 hours post-ensiling in both control and inoculated silages. Enterobacteriaceae declined slowly as ensiling progressed, but yeasts and molds did not decrease until after 42 days post-ensiling (Figure 7).

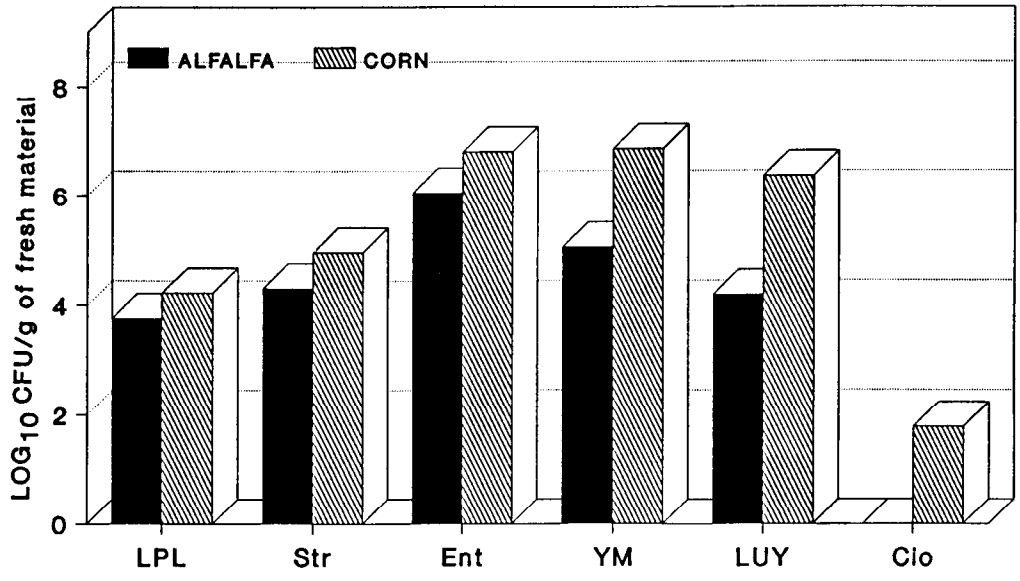

Figure 1. Effect of Crop Species on Epiphytic Microflora

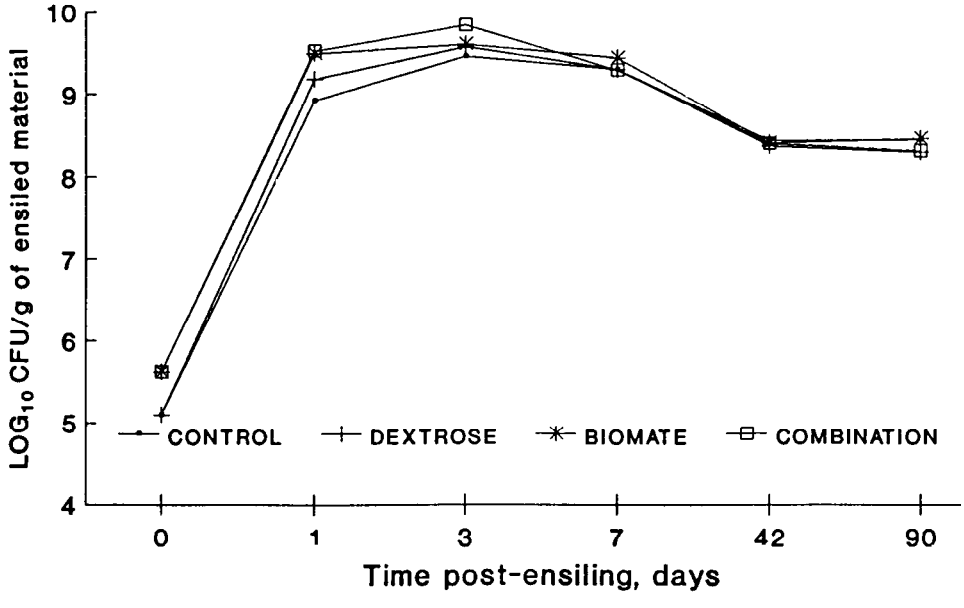

Figure 2. Effect of Silage Additives on LPL during the Ensiling Process of Alfalfa

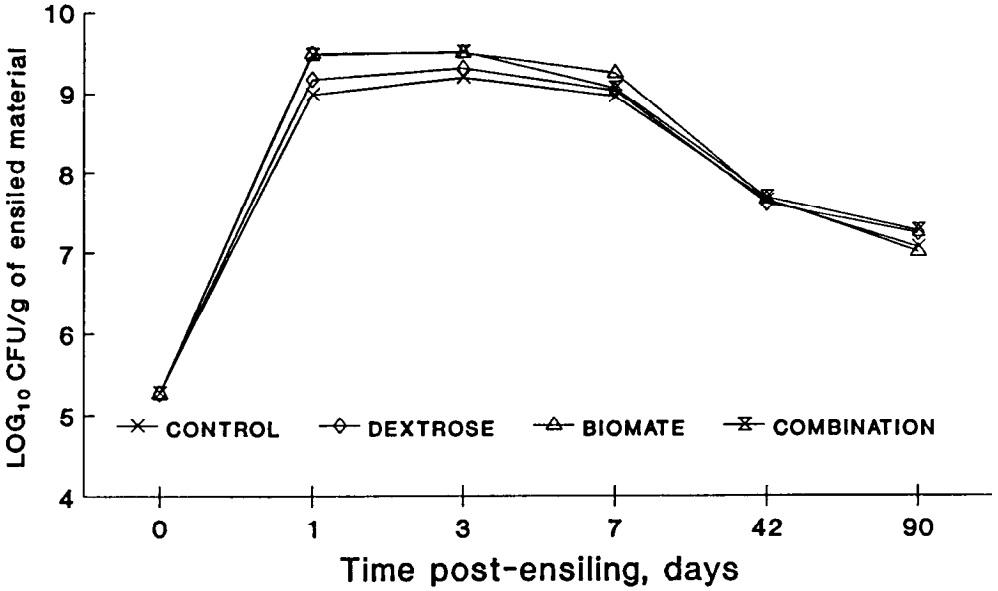

Figure 3. Effect of Silage Additives on Streptococci during the Ensiling Process of Alfalfa

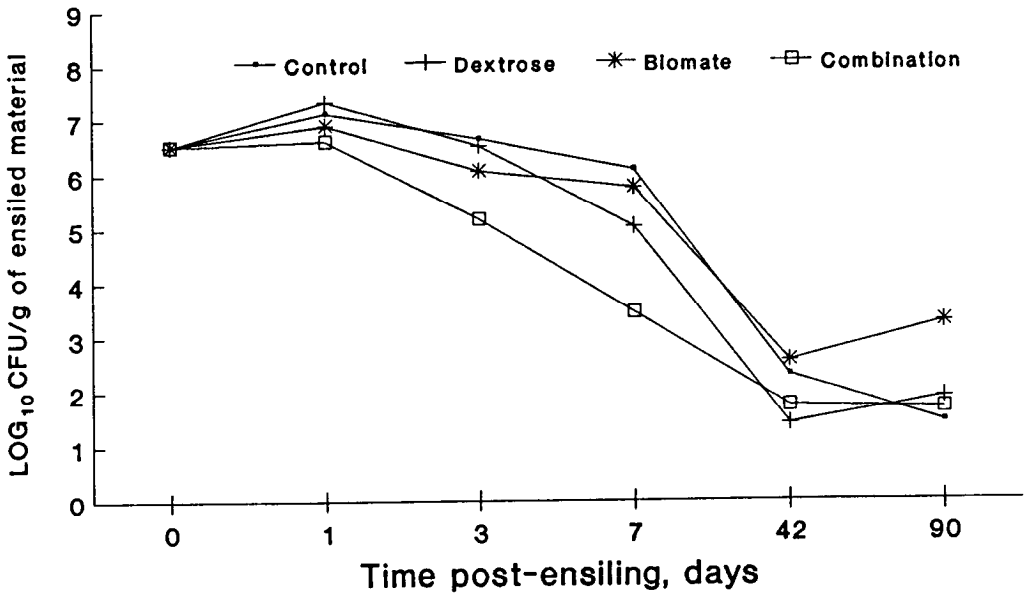

Figure 4. Effect of Silage Additives on Enterobacteriaceae during the Ensiling Process of Alfalfa

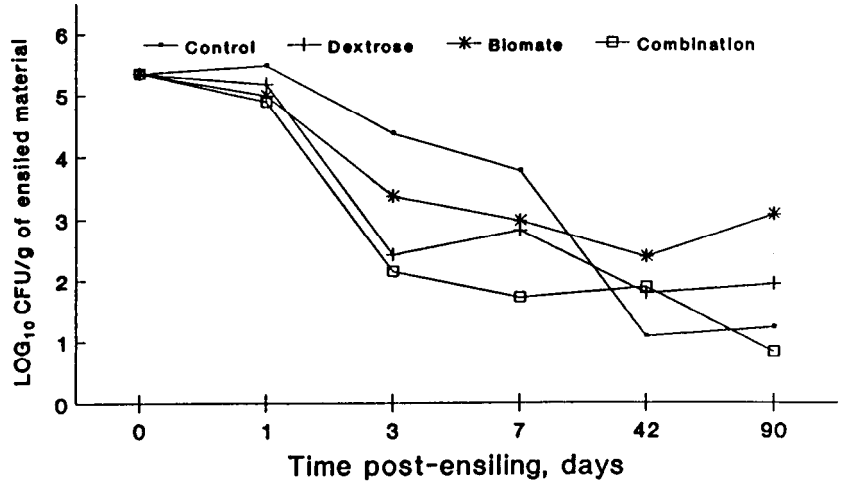

Figure 5. Effect of Silage Additives on Yeasts and Molds during the Ensiling Process of Alfalfa

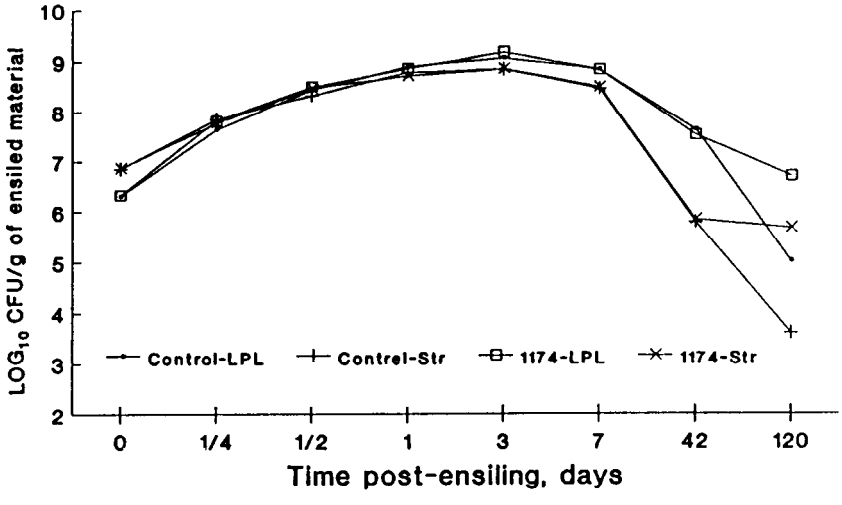

Figure 6. Effect of 1174 on LAB during the Ensiling Process of Corn

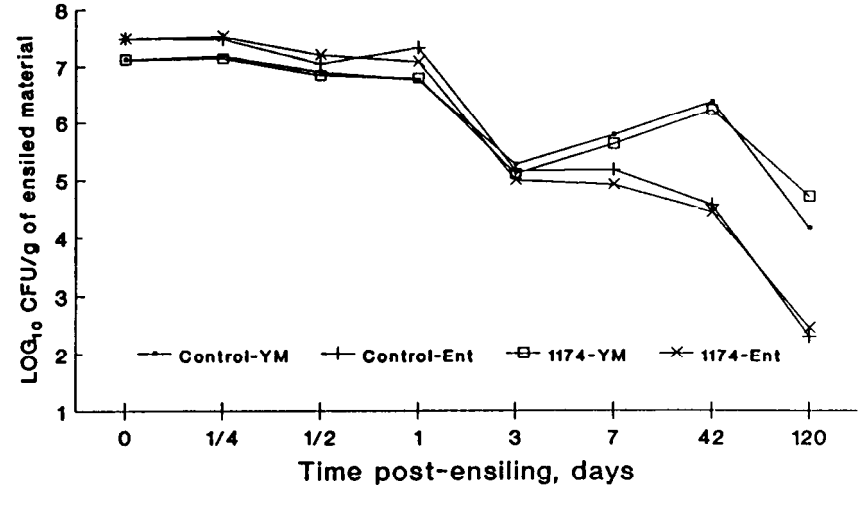

Figure 7. Effect of 1174 on Enterobacteriaceae, Yeasts, and Molds during the Ensiling Process of Corn

COMPARISON OF SYNOVEX-S® AND STEER-OID® IN FINISHING YEARLING STEERS

R. T. Brandt, Jr., S. J. Anderson[1], and J. K. Elliott[2]

Summary

Synovex-S (SS) and STEER-oid (SO) were compared in a 122-d finishing study. No differences were observed over the entire study for animal performance or carcass traits. However, in the final period (d 91-122), steers implanted with SO gained 8.4% faster (P = .17) and 8.7% more efficiently (P = .10) than steers implanted with SS, suggesting that estradiol payout in this period was less diminished for SO implants. The importance of this finding is unknown, because it is generally recommended that steers fed for longer periods of time be reimplanted midway through the finishing period to maintain maximal implant response.

(Key Words: Implant, Estradiol Comparison, Feedlot, Cattle.)

Introduction

Synovex-S® and STEER-oid® are commercially available anabolic ear implants. Both contain 20 mg estradiol benzoate and 200 mg progesterone as the active anabolic compounds. However, they are manufactured by different companies[3] using different processes. This has led to some discussion regarding differences in continuity and length of implant payout. Our study was conducted to evaluate efficacy of the two implants in a 122 d finishing trial.

Experimental Procedures

One hundred twelve yearling, English × Exotic crossbred steers (813 lb) were used to compare Synovex-S (SS) and STEER-oid (SO) in a finishing study. This study was superimposed on a previously reported study evaluating animal response to different sources of supplemental fat. Steers in eight pens (seven steers/pen) each were implanted with SS or SO at the initiation of the study, such that pens assigned to nutritional treatments were equally represented within each implant group. Steers were fed once daily a steam-flaked milo-based finishing diet with supplemental fat.

Initial and final weights were the average of two consecutive day full weights. Final weights were pencil shrunk 4% to reflect payweight performance. At the conclusion of the study (122 d), steers were slaughtered at IBP, Inc., Holcomb, and carcass data were collected following a 24 h chill.

Results and Discussion

Because the effective payout period of both implants is considered to be 70-100 d, data are presented for d 0-90, d 91-122 and for the overall study (d 0-122).

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[1]Current address: CRI Feeders, Guymon, OK.
[2]Southwest Kansas Research-Extension Center.
[3]Synovex-S® is marketed by Syntex Animal Health, West Des Moines, IA. STEER-oid® is marketed by Anchor Laboratories, St. Joseph, MO.

For the initial 90 d on feed, no differences were detected between implants for daily gain, feed consumption, or feed efficiency (Table 1). During the period from 91-122 d, however, steers implanted with SO gained 8.4% faster (P = .17) and 8.7% more efficiently (P = .10) than steers implanted with SS. These data suggest that the hormonal release rate may have begun to diminish for SS implants in this period.

Overall (0-122 d), there were no differences (P > .27) between implants in steer daily gain, feed consumption, feed efficiency, or carcass traits. We conclude that, for yearling steers fed for less than 122 d, SS and SO implants have similar effects on performance and carcass traits. Although data for the 91-122 d period suggested that hormone release may be extended for SO implants, steers fed for longer periods of time (130-160 d) should be reimplanted midway through the feeding period anyway to maintain maximal response and cost effectiveness of implants.

Table 1. Comparison of Synovex-S® and STEER-oid® on Performance and Carcass Traits of Finishing Yearling Steers

Item	Synovex-S	STEER-oid	SE[d]
No. pens	8	8	
No. steers	56	56	
Initial wt, lb	813	812	7.5
Final wt, lb[a]	1192	1195	5.2
0-90 d			
Daily gain, lb	3.68	3.63	.09
Daily feed, lb DM	19.32	18.94	.31
Feed/gain	5.28	5.22	.13
91-122 d			
Daily gain, lb[b]	3.09	3.35	.13
Daily feed, lb DM	20.40	20.31	.46
Feed/gain[c]	6.67	6.09	.24
0-122 d			
Daily gain, lb[a]	3.36	3.41	.06
Daily feed, lb DM	19.58	19.30	.30
Feed/gain	5.83	5.67	.10
Carcass data			
Hot wt, lb	764	764	6.6
Dressing percent	64.1	63.8	.31
Backfat, in.	.34	.34	.02
Marbling	Sl^{98}	Sm^{14}	.07
Percent choice	61	62	8.6

[a]Final weights pencil shrunk 4%.
[b]STEER-oid vs Synovex-S (P = .17).
[c]STEER-oid vs Synovex-S (P = .10).
[d]Standard error.

EVALUATION OF REVALOR®[1] IMPLANTS FOR STOCKER-FINISHING STEERS

R. T. Brandt, Jr., R. J. Grant[2], and R. V. Pope

Summary

Revalor® implants (containing trenbolone acetate plus estradiol) were evaluated in a grazing-finishing system using steers with a known previous implant history. Grazing gains were not improved by either Ralgro® or Revalor implants, suggesting that previously implanted steers may not respond to implants during a later growing phase. During the finishing phase, steers implanted with Revalor gained 5.4 to 8.0% faster ($P < .05$) than steers implanted with Synovex-S®. Gain efficiency in the finishing period was improved 4.8% ($P < .10$) for steers receiving no pasture implant and a Revalor implant during the finishing phase (0R), compared with steers receiving Ralgro/Synovex (RS) or Revalor/Revalor (RR) implants in the pasture/feedlot phases. Steers implanted with RR had larger ($P < .05$) ribeye areas than RS steers, with 0R steers intermediate. However, RR steers had a 20 percentage unit reduction ($P < .05$) in carcasses reaching the choice grade compared to RS steers. Revalor can improve steer feedlot performance, but multiple implantation may reduce quality grade.

(Key Words: Revalor, Steers, Growing, Finishing, Performance, Carcass Traits).

Introduction

Previous research has shown that concomitant use of trenbolone acetate (TBA; a synthetic androgenic growth promotant) implants with estrogenic implants sometimes results in synergistic effects on lean tissue growth and performance of feedlot cattle. As a result, some recent commercial research has focused on the development of a single implant containing both TBA and an estrogenic compound. Commercial availability of such an implant would simplify implanting procedures where both TBA and an estrogenic implant are deemed desirable, while eliminating regulatory concerns for feedyard managers regarding concomitant use of TBA with other implants. Revalor® is an implant containing both TBA and estradiol as growth promoting agents. The present study was conducted to evaluate the efficacy of Revalor implants in a summer grazing-finishing production system.

Experimental Procedures

Two hundred forty, crossbred, steer calves were obtained from one source in Clarksville, Texas and shipped to the KSU Beef Research Unit. Calves were weighed upon arrival and housed in four, large, drylot pens until placed on pasture.

Steers were randomly allotted within six weight replicates to one of four feedlot pens (10 head per pen, 240 total steers) before the grazing phase. Treatments (pasture implant/feedlot implant) were: 1) Ralgro/ Synovex-S (RS), 2) no implant/Revalor-S (0R), and 3) Revalor-S/Revalor-S (RR). Revalor implants used in the grazing and finishing phases contained 20/100 and 28/140 mg of estradiol/trenbolone acetate, respectively.

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[1]Revalor is not currently available for commercial use, although FDA clearance is expected in the near future.

[2]Group leader, Nutritional Research, Hoechst-Roussel Agri-Vet Co., Somerville, NJ.

Steers were group-pastured on native Flint Hills range in Chase County, Kansas, on a 1200 acre pasture. Predominant grass species included big bluestem, indiangrass, and switchgrass. At the conclusion of the grazing period, steers were gathered and shipped to Manhattan. Steers were weighed, and finishing phase implants were administered.

Results and Discussion

Pasture phase. There were no differences in daily gain as a result of pasture implant treatment (Table 1). Steers had been previously implanted 76 d before the start of the pasture phase with Synovex-S, because the effective payout rate of Synovex-S is about 85 d. Thus, it is unlikely that this drug continued to be released during the grazing phase of the study. However, lack of response to a growing phase implant that followed a previous implant has been reported in K-State and Nebraska research. Therefore, improved rates of gain should not always be expected from previously implanted animals on a moderate plane of nutrition (pasture or backgrounding situations where gain is less than 2 lb/d).

Feedlot phase. Steers implanted with Revalor during the feedlot phase only (0R) or during the pasture and feedlot phases (RR) gained 8.0 ($P < .05$) and 5.4% ($P < .10$) faster, respectively, than steers implanted with Ralgro during the pasture phase and Synovex-S during the finishing phase (RS). As can be seen in Table 1, most of the difference in final weights and average daily gain among treatments can be attributed to performance differences during the first 35 d on feed (Period 1).

Feed intake during the finishing period was 3.3 and 5.5% ($P < .05$) greater for 0R and RR vs RS steers. Most of the difference in overall feed consumption resulted from differences in Periods 2 and 3. Feed consumption for 0R and RR steers was 4.1 and 6.2% higher than that for RS steers in Period 2 and 6.1 and 7.7% ($P < .05$) higher in Period 3.

Overall, 0R steers were 4.8% more efficient ($P \leq .10$) than RS or RR steers in gain efficiency (gain/feed). Much of the difference in increased overall efficiency for 0R vs RS steers can be explained by differences in Period 1. Poor performance (daily gain and gain/feed) during Period 3 may be partially attributed to extremely harsh environmental conditions for the final 8 d of the period. Mean daily temperatures averaged 12°F, but low temperatures reached -16°F, and wind chill factors at times were below -50°F.

Carcass traits. Hot carcass weights were 9 and 7 lbs heavier ($P > .10$) for 0R and RR vs RS steers (Table 2). Ribeye area, expressed either as total area or area per unit of carcass weight, was greater ($P < .05$) for RR than for RS steers, with 0R steers intermediate. Backfat did not differ among treatments, but KPH fat was greater ($P < .05$) for 0R than for RS steers. Yield grade was lower ($P < .05$) and cutability (% trimmed retail cuts yield) was higher ($P < .05$) for RR than for 0R steers, with RS steers intermediate. Dressing percentage did not differ between treatments.

Degree of marbling was lower ($P = .06$) for RR than for 0R steers, with RS steers intermediate. However, two Revalor implants resulted in a 21 percentage unit reduction ($P < .05$) in Choice carcasses vs RS steers, and a 11.3 percentage unit reduction ($P > .10$) compared to steers implanted with Revalor during the finishing phase only.

Steers implanted twice with Revalor had a hide-pulling score that was 16 and 17.9% greater (more difficult, $P < .05$) than that for RS or 0R steers, respectively. Although highly subjective and empirical in nature, similar results have been observed at K-State for finishing cattle implanted with trenbolone acetate.

Percentage condemnations of livers because of abscesses, flukes, or distoma did

not differ significantly among treatments and were 17.6, 13.1, and 6.8%, respectively. Simple correlations revealed no relationship between any of these causes of liver condemnations and animal performance (weight gain) in this study.

Table 1. Effect of Revalor® on Growing-Finishing Performance of Steers

Item	Pasture implant: Ralgro Feedlot implant: Synovex	None Revalor	Revalor Revalor	SE[b]
Pasture phase (139 d)				
No. steers	59	60	120	
Initial wt, lb[a]	526	524	526	6
Off pasture wt, lb[a]	739	735	734	8
Daily gain, lb	1.53	1.52	1.50	.24
Feedlot phase (88 d)				
No. pens	6	6	12	
No. steers	57	60	114	
Final wt, lb[a]	1073[e]	1098[f]	1088[ef]	8.6
Period 1 (35 d):				
Daily gain, lb	3.76[c]	4.17[d]	4.14[d]	.09
Daily feed, lb DM	20.05	20.12	20.68	.35
Gain/feed	.188[e]	.208[d]	.201[d]	.004
Period 2 (25 d):				
Daily gain, lb	3.70	4.02	3.94	.15
Daily feed, lb DM	22.18[c]	23.08[cd]	23.56[d]	.43
Gain/feed	.167	.174	.167	.006
Period 3 (28 d):				
Daily gain, lb	2.86	2.98	2.79	.12
Daily feed, lb DM	21.11[c]	22.39[d]	22.74[d]	.36
Gain/feed	.135[e]	.133[ef]	.123[f]	.005
Total (0 to 88 d):				
Daily gain, lb	3.50[e]	3.78[f]	3.69[f]	.08
Daily feed, lb DM	20.98[c]	21.68[cd]	22.14[d]	
Gain/feed	.167[e]	.175[f]	.167[e]	.003

[a]Initial and final pasture weights were obtained following an overnight stand, during which steers had no access to feed or water. Final pasture weights were initial feedlot weights.
Interim and final feedlot weights were early morning, full weights pencil shrunk 4%.
[b]Standard error.
[cd]Means in a row without a common superscript differ (P < .05).
[ef]Means in a row without a common superscript differ (P < .10).

Table 2. Effect of Revalor® on Slaughter and Carcass Variables

Item	Pasture implant: Ralgro Feedlot implant: Synovex	None Revalor	Revalor Revalor	SE
Hot carcass wt, lb	683	692	690	4.7
Ribeye area,				
in^2	12.59^{f}	12.85^{fg}	13.17^{g}	.18
in^2/100 lb carcass wt	1.84^{f}	1.86^{fg}	1.92^{g}	.02
Backfat, in	.37	.39	.36	.02
KPH fat, %[a]	2.47^{f}	2.70^{g}	2.55^{fg}	.05
Yield grade[b]	2.48^{fg}	2.54^{g}	2.31^{f}	.08
Cutability, %[b]	51.0^{fg}	50.9^{f}	51.4^{g}	.18
Dressing percentage	63.7	63.0	63.5	.39
Marbling[c]	4.81^{hi}	4.90^{i}	4.77^{h}	.05
Percent Choice	61.4^{g}	51.7^{fg}	40.4^{f}	6.28
Skeletal maturity[d]	1.67	1.74	1.69	.03
Hide pull score[e]	3.18^{f}	3.13^{f}	3.69^{g}	.09

[a]Kidney, pelvic, and heart fat.
[b]Calculated using USDA equations.
[c]$Slight^{50}$ = 4.5, $Small^{50}$ = 5.5, etc.
[d]A^{50} = 1.5, B^{50} = 2.5, etc.
[e]Scale of 1 to 5; 1 = easy pull, 5 = very difficult.
[fg]Means in a row without a common superscript differ ($P < .05$).
[hi]Means in a row without a common superscript differ ($P = .06$).

TIMING OF TRENBOLONE ACETATE IMPLANTS ON PERFORMANCE, CARCASS CHARACTERISTICS, AND BEEF QUALITY OF FINISHING STEER CALVES

G. L. Huck, R. T. Brandt, Jr., M. E. Dikeman, D. D. Simms, and G. L. Kuhl

Summary

Angus and Angus-cross calves (632 lb) were utilized in a finishing study to evaluate the effects of implanting with estradiol and progesterone (Synovex-S®) and(or) trenbolone acetate (Finaplix®) on performance of finishing steers. Over the entire finishing period (117 d), implanted steers had higher ($P < .05$) daily gains and were more efficient than nonimplanted steers. Carcasses from implanted cattle had heavier ($P < .05$) hot weights and larger ($P < .05$) ribeye areas. Steers implanted with Finaplix had larger ($P < .05$) ribeye areas than those implanted with Synovex only. Marbling scores and quality grades were not affected by implant treatments. Rib (9-10-11) sections from implanted steers were heavier ($P < .05$) as a result of both heavier ($P < .05$) bone and soft tissue weights. However, no differences in percentages of protein, fat, and moisture were detected by proximate analysis of the soft tissue. Concomitant use of Finaplix with Synovex-S did not affect performance of Angus and Angus-crossed steer calves.

(Key Words: Trenbolone Acetate, Performance, Carcass Traits, Chemical Composition)

Introduction

Substantial liveweight gain responses have been reported from implanting anabolic agents in finishing beef steers. Finaplix® (F), an implant containing trenbolone acetate, an anabolic androgenic steroid, has been shown to increase muscle to bone ratio and ribeye area and decrease both subcutaneous and intramuscular fat. Gain is further enhanced when F is used in combination with an estrogenic agent such as Synovex (S). Research at other universities has shown that Finaplix may reduce quality grade by 8 to 10%. Whether implanting Finaplix early in the finishing period will lessen this reduction in grade is not clear. Nor do we know the effect on carcass characteristics of implanting early with F followed by a subsequent F implant midway through the finishing period. Therefore, our objectives were to determine the effects of 1) implanting F early and late in the finishing period and 2) implanting F one or two times on animal performance, carcass traits, and beef palatability estimates.

Experimental Procedures

Eighty springborn, Angus and Angus-crossbred, steer calves (632 lb) were used to evaluate the following treatments: 1) non-implanted control (C); 2) implanted with S twice; 3) implanted with S then S + F; 4) implanted with S + F then S; and 5) implanted with S + F twice. Treatment groups consisted of four replications of four animals per pen. Reimplanting occurred on d 69 of the finishing period.

Cattle from the two heaviest replications were slaughtered after 110 d, and the re-

maining two replications were slaughtered 14 d later, at the IBP Inc. packing plant in Emporia, Kansas. USDA quality and yield grades were obtained 24 h postmortem. Whole rib sections from all steers were removed and shipped to the KSU Meats Laboratory and aged until 6 d postmortem. Two 1-inch-thick ribeye steaks were removed for Warner-Bratzler shear and collagen solubility determinations. The 9-10-11 rib section was isolated, weighed and physically separated into bone and soft tissue components. The soft tissue was ground, subsampled, and frozen for subsequent chemical analysis.

Results and Discussion

Implanted steers gained 14% faster ($P < .05$) while consuming 6% more ($P < .05$) dry matter over the entire feeding period, resulting in an 8.3% improvement ($P < .05$) in feed efficiency over control steers (Table 1). No significant differences were observed in ADG, feed intake, or feed efficiency among the implanted treatment groups.

Marbling scores and quality grades were not affected by implant treatment. This is in contrast to other university research showing that implanted cattle may have carcasses with lower USDA quality grades than non-implanted cattle. Steers in our experiment were of Angus or Angus-cross breeding, which suggests that breed type may have had a stronger influence than the implant treatment on quality grade.

Nonimplanted control cattle had lower ($P < .05$) hot carcass weights and smaller ($P < .05$) ribeye areas than implanted cattle. Steers implanted with Finaplix once or twice had larger ($P < .05$) ribeye areas than those implanted with S alone. Further, steers implanted twice with Finaplix had 3.4% larger ($P < .05$) ribeye areas than steers implanted only once. Implanting had no significant effect on dressing percent, kidney knob, or USDA yield grade, although steers implanted with Finaplix had numerically lower yield grades.

Weights of the 9-10-11 rib sections were higher ($P < .05$) for implanted cattle because of an increase ($P < .05$) in weight of both bone and soft tissue. Proximate analysis of the soft tissue from the 9, 10 and 11th rib sections indicated that implanting with Finaplix either once or twice, early or late, in the finishing period had no significant effect on soft tissue chemical composition. However, the soft tissue from steers receiving F was 4.7% higher in protein and 8.2% lower in fat content than control steers. This suggests a trend for more protein and less fat accretion in steers implanted with Finaplix versus nonimplanted steers.

Estimates of palatability as measured by Warner-Bratzler shear and collagen content did not differ among treatments. This suggests that implanting young finishing cattle with S or S + F does not affect beef palatability.

Table 1. Effects of Implant Treatments on Steer Feedlot Performance, Carcass Traits, and 9-10-11 Rib Chemical Composition

		Treatment[a]				
		(1)	(2)	(3)	(4)	(5)
	Day 0:	C	S	S	S + F	S + F
Item	Day 69:	C	S	S + F	S	S + F
Performance Data						
No. pens		4	4	4	4	4
No. steers		16	16	16	16	16
Initial wt, lb		631	632	633	633	634
Final wt, lb[b]		1072	1122	1137	1147	1146
Average daily gain, lb[b]		3.8	4.2	4.3	4.4	4.4
Feed intake, lb DM[b]		19.9	21.1	21.4	21.1	21.1
Gain/feed[b]		.189	.201	.203	.211	.209
Carcass Data						
Dressing percent		64	64	63	64	64
Carcass wt, lb [b]		661	689	693	704	702
Fat thickness, in.		.48	.49	.47	.46	.49
Ribeye area, in^2 [bcd]		11.9	12.4	12.6	12.9	13.2
KPH fat, %		2.3	2.2	2.2	2.1	2.1
USDA yield grade		2.9	2.9	2.8	2.6	2.6
Quality grade [e]		207	202	195	187	195
Choice, %		66	75	62	50	62
Composition Data						
Shear force, lb		8.1	8.6	8.6	9.1	8.2
Soluble collagen, %		3.0	2.1	2.6	2.1	2.7
9-10-11 rib wt, lb [b]		13.0	13.8	13.6	13.9	14.0
Bone wt, lb [b]		2.0	2.1	2.1	2.2	2.2
Soft tissue wt, lb [b]		11.0	11.7	11.5	11.7	11.8
Protein, %		12.9	13.0	13.2	13.4	13.9
Ether extract, %		38.9	36.9	35.7	37.4	33.9
Moisture, %		46.7	48.0	48.8	46.6	50.0

[a]C = Control; F = Finaplix; S = Synovex-S.
[b]Treatment 1 vs treatments 2, 3, 4 and 5 ($P < .05$).
[c]Treatment 2 vs treatments 3, 4, and 5 ($P < .05$).
[d]Treatments 3 and 4 vs treatment 5 ($P < .05$).
[e]0-99 = USDA Standard; 100-199 = USDA Select; 200-299 = USDA Choice.

MONENSIN LEVELS IN A STEAM-FLAKED MILO FINISHING DIET WITH 4% ADDED FAT

R. T. Brandt, Jr., S. J. Anderson[1], and J. K. Elliott[2]

Summary

Response to monensin (Control, 12.5, or 25 g/ton, air dry basis) by yearling steers fed a diet with 4% added fat was evaluated. For the entire study (104 d), daily gain, feed consumption and feed efficiency were unaffected (P > .25) by monensin. These results are in general agreement with some of our previous reports of diminished animal response to ionophores in fat-supplemented finishing diets. No adverse effects on animal health have been observed in our studies. However, whether withdrawing ionophores from finishing rations with 3.5-4% fat will affect the incidence of digestive upsets in commercial applications is not clear.

(Key Words: Monensin Level, Fat, Cattle, Feedlot Performance.)

Introduction

Results from the previous report as well as from other Kansas State research has suggested that animal response to ionophores may be altered by addition of fat to finishing diets. This trial was conducted to evaluate the effect of two levels of monensin on performance and carcass traits of steers fed a steam-flaked milo diet containing 4% added fat.

Experimental Procedures

One hundred and five, yearling, British × Exotic crossbred steers (821 lb) were utilized to evaluate the effects of two levels of monensin (Control, 12.5, or 25 g/ton, air dry basis) in a finishing diet containing 4% added fat. Steers were processed as described in the previous report and adjusted stepwise on a common diet to full feed in 10 days. Steers were weighed on 2 consecutive days, allotted to pens in a randomized complete block design, and placed on the experimental diet (Table 1). There were five pen replicates (seven head per pen) per treatment. Milo was flaked (26 lb/bu) and fed fresh daily. Tylosin was included in all rations at 10 g/ton (air dry basis). The appropriate levels of monensin and tylosin were added to the daily ration by way of a computer-operated microingredient machine. Steers on the 25 g monensin/ton treatment received 12.5 g/ton for the first 7 d.

Table 1. Composition of Experimental Diet[a]

Ingredient	%, dry matter basis
Steam flaked milo	83.0
Alfalfa hay	4.0
Corn silage	4.0
Pelleted supplement	5.0
Yellow grease	4.0

[a]Contained 12.4% CP, .64% Ca, .32%

At the conclusion of the study (104 d), final weights were obtained on 2 consecutive days, and the steers were slaughtered at IBP, Inc.,

[1]Present address: CRI Feeders, Guymon, OK.
[2]Southwest Kansas Research-Extension Center.

Holcomb. Carcass data were collected following a 24-h chill.

Results and Discussion

During the initial 28 d of the study, feed intake decreased linearly (P = .10) with increased monensin (Table 2). Daily gain and feed efficiency were not influenced by monensin.

For the entire feeding period, monensin did not affect (P > .25) daily gain or feed consumption. Similarly, improvements in feed efficiency of 2.2 and 1.4% for the 12.5 and 25 g monensin/ton treatments, respectively, were not statistically significant. These data are in general agreement with our previous reports suggesting that animal performance responses to ionophores in finishing diets may be diminished substantially by supplemental fat. However, the effects on animal health of removing ionophores from finishing diets containing fat, particularly as it relates to digestive upsets such as acidosis and bloat, is unknown. Although no health problems have been observed in our studies, work is needed to evaluate the potential management risk involved in commercial applications.

No differences existed between treatments for carcass traits, with the exception of dressing percent, which decreased linearly (P < .05) with increased monensin. This has not been observed in previous studies, and a sound biological explanation for this result is not readily apparent.

Table 2. Fat and Monensin Effects on Steer Performance and Carcass Traits

Item	Monensin level, g/ton 0	12.5	25	SE[d]
No. pens	5	5	5	
No. steers	35	35	35	
Initial wt, lb	821	821	821	.6
Final wt, lb[a]	1184	1194	1192	9.6
0-28 d				
Daily gain, lb	3.07	3.28	2.71	.26
Daily feed, lb DM[b]	17.22	16.95	16.43	.31
Feed/gain	5.73	5.19	6.44	.53
0-104 d				
Daily gain, lb[a]	3.50	3.59	3.56	.09
Daily feed, lb DM	21.96	21.77	22.35	.47
Feed/gain	5.78	5.65	5.70	.15
Carcass data				
Hot wt, lb	748	752	740	5.8
Dressing percent[c]	63.1	63.0	62.1	.33
Backfat, in.	.38	.44	.38	.02
Marbling	Sm[40]	Sm[65]	Sm[63]	.15
Percent choice	72	79	82	8.1

[a]Final weights were pencil shrunk 4%.

EFFECTS OF SPEED OF RATION STEP-UP AND MONENSIN ON RUMINAL PH, LACTATE, AND PROTOZOAL POPULATION IN FEEDLOT CATTLE

T. G. Nagaraja, G. Towne, and R. T. Brandt, Jr.

Summary

Fluctuations in ruminal pH, lactate concentration, and ciliated protozoal population were monitored in 40 individually fed crossbred heifers that were stepped up to an 85% concentrate diet either slowly (12 d) or rapidly (3 d), with or without monensin (30 ppm). Speed of step-up affected ruminal pH, lactate concentration and protozoal population initially (up to 28 d), but thereafter no differences occurred between the groups, suggesting adaptation to ruminal conditions. Monensin had no effect on ruminal pH, lactate concentration, or protozoal population.

(Key words: Ruminal Microorganisms, Step-up Monensin, Feedlot Cattle.)

Introduction

When cattle are switched from a high-forage to a high-grain diet, the ruminal microbial population undergoes a dramatic shift. How quickly cattle are stepped to a high grain diet could have a major influence on microbes, particularly protozoa. Previous studies have followed microbial changes for short periods and with restricted feed intakes. Therefore, our objectives were to determine the influence of speed of step-up on ruminal pH, lactate concentration, and protozoal population from the beginning of the finishing period until slaughter, in cattle fed ad libitum.

Experimental Procedures

Forty Hereford-Angus heifers (average weight, 680 lb), previously fed a sorghum silage diet, were randomly allotted to one of four treatments in a 2 × 2 factorial arrangement. The main treatments were speed of step-up (slow or rapid) and monensin (without or with 30 ppm). Cattle in the slow step-up program were fed 25, 40, 55 and 70% corn diets in successive increments (3 d for each increment) before being placed on the final diet. Cattle in the rapid step-up program were fed a 70% concentrate diet for 3 d before receiving the final diet. The final diet consisted of 85% cracked corn, 10% roughage (dehydrated alfalfa and sorghum silage), and 5% supplement. The cattle were individually fed once daily in amounts sufficient to allow ad libitum intake.

Ruminal contents were collected by stomach tube from all 40 animals on the day before feeding grain (d 0), after the rapid step-up (d 5), after the slow step-up group reached full feed (d 14), and at 14-d intervals thereafter until slaughter (d 119). Ruminal contents were analyzed for pH, lactate, and protozoal counts.

Results and Discussion

Ruminal pH was highest before beginning the grain feeding (7.17 on d 0) and lowest on d 56 (5.29). Statistical analysis on only the first four sampling dates revealed that average ruminal pH was higher ($P < 0.01$) in heifers stepped up slowly (6.45) than in heifers stepped up rapidly (6.22). However, ruminal pH thereafter fluctuated similarly in both groups of cattle. Following adaptation to full feed, ruminal pH progressively increased and eventually stabilized (except on d 56, Figure 1). In both groups, ruminal lactate concentration peaked when the animals reached full feed (50 mM on d 5 in cattle stepped-up rapidly and 29 mM on d 14 in cattle stepped-up slowly) and then declined to extremely low levels. The speed of step-up had no effect on ruminal lactate

concentration.

Protozoa1 numbers decreased from d 0 to d 5 in the rapid step-up program but increased in the slow step-up program. After d 5, protozoal counts in both groups followed similar fluctuations (Figure 2). Average protozoal. numbers peaked on d 5, progressively declined until d 56 ($P<.05$), and then increased ($P<.05$), suggesting an adaptation of protozoa1 population to ruminal conditions. At the beginning of the study, the cattle possessed various concentrations of 11 protozoa1 genera, but after d 28, only three genera survived. The number of cattle devoid of protozoa (defaunated) ranged from 1 on d 14 to 11 on d 42 and d 56 and then dropped to 2 on d 119; the speed of step-up did not affect ($P>.10$) the number of defaunated animals at any sampling time. Although cattle were individually penned, isolation was not absolute, and cattle could have been exogenously reinoculated from a faunated neighbor. Alternatively, refaunation may have been endogenous, with the protozoa either surviving in the rumen at undetectable levels or emigrating from the omasum and then rapidly proliferating as ruminal conditions improved. Regardless of the source of inoculum, defaunation in feedlot cattle is apparently transitory.

Generally, monensin had no effect on ruminal pH, lactate concentration, or protozoal population. However, monensin-fed heifers tended to have higher ruminal pH (6.40) than those receiving no monensin (6.28). The beneficial effect of monensin tended to be more pronounced in cattle stepped up rapidly (ruminal pH 6.34 vs 6.11 for monensin fed and control heifers, respectively) than in cattle stepped up slowly (6.46 vs 6.44).

We concluded that the effect of speed of step-up on ruminal conditions was confined to the initial 28 d of the feeding period. Defaunation is apparently transitory, and cattle harbor a dynamic protozoa1 population that fluctuates in response to changing ruminal conditions.

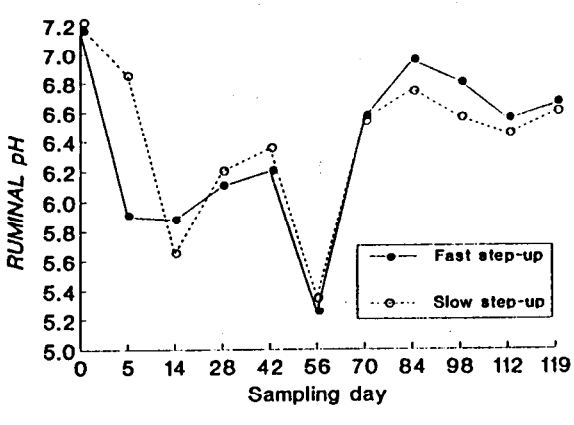


Figure 1. Influence of Speed of Ration Step-up on Ruminal pH in Feedlot Cattle. Each Value Represents Mean of 20 Cattle

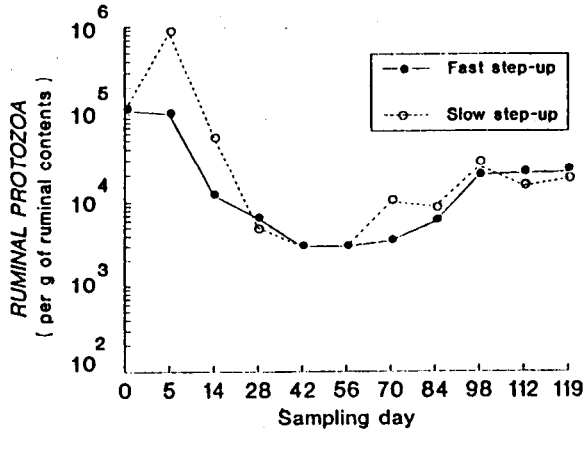


Figure 2. Influence of Speed of Ration Step-up on Ruminal Ciliated Protozoa Each Value Represents Mean of 20 Cattle

INFLUENCE OF SUPPLEMENTAL FAT AND MONENSIN PLUS TYLOSIN ON PERFORMANCE AND CARCASS TRAITS OF FINISHING STEERS

R.T. Brandt, Jr., T.G. Nagaraja, and J.K. Elliott[1]

Summary

Interactions between supplemental fat (3.5%) and monensin plus tylosin (25 plus 10 g/ton, respectively) on animal performance and carcass traits were evaluated in a 125-d finishing trial. Interactions on feed consumption (P = .07) and feed efficiency (P = .11) suggested that the ionophore response was diminished in the presence of supplemental fat. Steers fed monensin plus tylosin had a lower (P = .005) incidence of liver abscesses whether fat was fed or not, indicating that supplemental fat had no effect on tylosin activity.

(Key Words: Monensin, Tylosin, Fat, Liver abscess, Cattle Performance.)

Introduction

Supplemental fat additions to feedlot finishing diets can improve animal performance and reduce cost of production in some situations. However, how fat interacts with other dietary ingredients and(or) nutrients has not been thoroughly evaluated. One such case is the animal response to ionophores in high (4-6%) fat-containing rations. It is possible that response to the ionophore may be altered, because ionophore antibiotics are fat-soluble compounds, and(or) some fats have antimicrobial activity of their own in the rumen. Previous research at Kansas State has shown a diminished response to ionophores with finishing diets containing 3.5-4% fat. The present study was conducted to further evaluate potential interactions between supplemental fat and ionophores in finishing diets.

Experimental Procedures

One hundred twenty-eight, mixed British, crossbred, feeder steers (692 lb) were utilized in a 2 × 2 factorially arranged, randomized, complete block experiment. Main effects evaluated were monensin/tylosin supplementation (0/0 or 25/10 g/ton, respectively, air dry basis) and supplemental fat (0 or 3.5% yellow grease). Steers were implanted; treated for internal and external parasites; and vaccinated against IBR, BVD, PI_3 and seven clostridial species. Steers were weighed full on 2 consecutive days, allotted to pens (2 pens of 11 head and one pen of 10 head per treatment combination), and stepped up in 9 d to the treatment diets (Table 1). Steers receiving monensin and tylosin were fed 12.5 and 10 g/ton, respectively, for 7 d before being placed on the final level of 25 and 10 g/ton. The trial was conducted for 125 d at the Southwest Kansas Research-Extension Center, Garden City. Final weights were the average of weights on 2 consecutive days. The steers were slaughtered at IBP, Inc., Holcomb, and carcass data were collected following a 24 h chill.

Results and Discussion

During the initial 39 d of the study, fat and monensin/tylosin (MT) interacted (P = .06) on feed efficiency (feed/gain, Table 2). Compared to steers fed no fat or MT, steers fed MT (with no fat) gained 6.4% more efficiently. Addition of fat to the MT-containing diet increased feed requirements, suggesting that a period of time may be required for adaptation to this treatment.

[1]Southwest Kansas Research-Extension Center, Garden City.

Over the entire trial (0-125 d), supplemental fat and MT interacted on DM intake (P = .07). For steers fed no fat, MT reduced intake 4.8%. However, addition of fat to the MT-containing diet did not suppress intake. The same trend was observed during the initial 39 d period. The intake response noted here is consistent with previous research we have conducted and seems to suggest that fat supplementation may interact with monensin to alleviate its effect on intake suppression.

A fat by MT interaction was also observed (P = .11) for feed efficiency. Addition of fat or MT to the basal diet improved feed efficiency by 7.4 or 7.2%, respectively. However, the combination of fat and MT resulted in no improvement in efficiency compared to fat or MT independently. These data suggest that the ionophore response by feedlot cattle is not additive to fat in diets at a 3.5% level.

Fat supplementation increased (P < .05) hot carcass weights and dressing percent and tended (P = .15) to increase backfat thickness. These results are consistent with previous research with finishing yearling steers fed supplemental fat in excess of 120 d.

Steers fed MT had a lower (P = .005) incidence of liver abscesses, irrespective of whether MT was added to the diet, indicating that supplemental fat did not negatively effect the activity of tylosin.

Table 1. Composition of Diets[a]

Ingredient	0% Fat	3.5% Fat
Steam-rolled wheat	41.7	41.5
Cracked corn	41.7	41.5
Alfalfa hay	4.0	4.0
Corn silage	4.0	4.0
Pelleted supplement	5.1	5.5
Molasses	3.5	-
Yellow grease	-	3.5

Dry basis. Diets contained 12.6% CP,

Table 2. Fat and Monensin/Tylosin Effects on Steer Performance and Carcass Traits

	– Monensin/tylosin		+ Monensin/tylosin		
Item	0% Fat	4% Fat	0% Fat	4% Fat	SE
No. pens	3	3	3	3	
No. steers	32	32	32	32	
Initial wt, lb	692	690	695	691	2.0
Final wt, lb[a]	1077	1096	1088	1097	11.4
0-39 d					
Daily gain, lb	3.82	3.83	3.98	3.55	.14
Daily feed, lb DM	17.33	17.11	16.73	17.30	.33
Feed/gain[b]	4.54	4.46	4.25	4.87	.15
0-125 d					
Daily gain, lb[a]	3.08	3.24	3.15	3.25	.09
Daily feed, lb DM[b]	18.60	18.26	17.70	18.38	.24
Feed/gain[c]	6.08	5.63	5.64	5.67	.13
Carcass data					
Hot wt, lb[d]	683	705	687	702	8.6
Dressing percent[d]	65.5	66.1	65.1	65.9	.28
Backfat, in	.38	.40	.36	.41	.03
Marbling	Sl^{74}	Sl^{59}	Sl^{70}	Sl^{75}	.11
Liver abscesses,%[e]	28	42	6	3	7.2

[a]Final weights were pencil shrunk 4%.
[b]Fat × ionophore interaction (P < .08).
[c]Fat × ionophore interaction (P = .11).
[d]Fat effect (P < .05).
[e]Monensin/tylosin effect (P = .005).

EFFECTS OF SUPPLEMENTAL GROUND GRAIN SORGHUM DURING GRAZING OF ENDOPHYTE-INFECTED TALL FESCUE ON GRAZING AND SUBSEQUENT FEEDLOT PERFORMANCE OF STEERS

A. S. Freeman[1] and K. P. Coffey[2]

Summary

Sixty-three crossbred steers (740 lb BW) were used to evaluate the effects of energy supplementation during grazing of endoplyte-infected tall fescue and on their subsequent feedlot performance. Grazing ADG was .53 lb/d for control (no supplementation) vs. .81 and 1.21 lb/d with .25% and .5% of BW as ground sorghum (GS), respectively. Grazing supplementation did not affect (P > .10) feedlot performance. Steers receiving .25% GS were 2.3% and 6.2% more efficient (P < .07) during the feedlot phase than 0% and .5% GS steers, respectively. The .5% GS steers were 3.8% less efficient (P < .07) during the feedlot phase than the 0% GS steers. Steers receiving grazing supplementation had increased (P < .07) adjusted backfat measurements and less desirable (P < .02) yield grades than non-supplemental controls. Supplementing steers grazing endophyte-infected fescue at .25% of BW with ground grain sorghum improved feedlot feed conversion compared to no supplementation and supplementing at .5% BW.

(Key Words: Sorghum Grain, Steers, Grazing Performance, Feedlot Performance, Fescue, Endophyte.)

Introduction

Cattle grazing endophyte-infected fescue frequently show signs of fescue toxicosis or 'summer slump' and are often discounted when purchased by feedlots. Various management practices have been applied to help relieve the problems. One possibility is to provide supplemental energy as grain to grazing cattle, thus diluting the toxins. This study was designed to investigate the effects of supplemental ground sorghum grain (GS) during grazing of endophyte-infected fescue on the subsequent feedlot performance of beef steers.

Experimental Procedures

Grazing Phase. Ninety steers that had been previously vaccinated against IBR, BVD, PI_3, 5 strains of leptosporosis, and 7 clostridial strains were co-mingled for 7 days on an endophyte-free fescue, bromegrass, and native grass (45 acre) pasture at the Southeast Kansas Branch Experiment Station, Parsons, KS. Initial full weights were measured on May 8 and 9. Steers were also vaccinated against pinkeye and BRSV, dewormed with levamisole, tagged with insecticide ear tags, and randomly allotted by weight into nine lots of seven head each.

Steers were then transported to one of nine 5-acre tall fescue pastures and assigned to either control (0%) or .25% or .5% of BW as GS per head daily. The remaining 27 head were used as needed to control excess forage on the experimental pastures.

The pastures were grazed from May 9 until July 3 using a put-and-take grazing system to ensure uniform forage availability across pastures. Water and mineral blocks containing monensin were provided freechoice.

Interim weights were taken on May 29 and

[1]Southwest Kansas Research-Extension Center, Garden City, Kansas.
[2]Southeast Kansas Branch Experiment Station, Parsons, Kansas.

June 20 with GS adjusted accordingly. The cattle were weighed on the morning of July 3 and moved to the previously grazed 45-acre mixed grass pasture for a 7 d period. Final full pasture weights were measured on July 9 and 10, and the cattle were moved to a local stockyard and fed prairie hay during the day. That evening, all ninety steers were transported to the Southwest Kansas Research-Extension Center, Garden City, KS for the feedlot phase of the trial.

Feedlot Phase. Cattle arrived by 5:30 am on July 11 and were individually weighed off the truck, than Tiguvon® (Fenthion) was administered. Steers were divided into groups of 10 head and placed in feedlot pens with fresh bromegrass hay and water overnight. On July 12, the second initial weight was obtained, and all 90 steers were implanted with Compudose 200®. Steers were sorted into seven head per pen to maintain grazing phase treatment replications.

All steers received a starter ration on July 12 and were brought up to full feed of a steam-flaked corn finishing diet over 13 days. On July 24, cattle were revaccinated against IBR, BVD, PI_3, 5 strains of leptosporosis, and dewormed with Valbazen® (Albendazole). Deccox® (Decoquinate) was fed (180 mg/head/day) for 33 days, then removed from the ration. Rumensin® (Monensin) and Tylan® (Tylosin) were then fed for 7 days at 150 and 90 mg/head/day, respectively. Monensin was subsequently increased to 300 mg/head/day for the remaining feedlot period.

Interim weights were taken on Sept. 13 and Oct. 25 and final weights on Nov. 19 and 20. Carcass characteristics were obtained after a 24 h chill.

Results and Discussion

Grazing Phase. Steers receiving 0% GS gained 33 lbs during the 62 d grazing phase for an ADG of .53 lb (Table 1). The .25% GS steers gained an additional .28 lb/d for a total gain of 50 lb per head. Steers consuming .5% of BW as GS had an ADG of 1.21 lb, resulting in an additional 42 lb of gain compared with the 0% group. Grain consumptions were 0, 105, and 215 lb for the 0, .25, and .5% GS grain supplement treatments, respectively.

Feedlot Phase. Cattle experienced an average transit shrink of 7.4% (Table 1). Steers receiving 0% GS shrank .5% more than those fed .25 or .5% GS. However, the 0 and .5% GS steers both gained 520 lb during the feedlot phase. Steers receiving .25% GS gained 12 lb more ($P > .10$) than those fed 0 and .5% GS. Feedlot dry matter intake and ADG were not affected ($P > .10$) by pasture treatments. However, steers receiving .25% of BW as GS required 2.3% and 6.2% less feed per unit gain ($P < .07$) during the feedlot phase compared with 0% GS and .5% GS steers. The .5% GS steers were 3.8% less efficient ($P < .07$) than the 0% GS steers. Combined ADG was not affected ($P > .10$) by pasture treatments.

Hot carcass weight (avg 764 lb), rib-eye-area (avg 12.8 $in.^2$), KPH (avg 2.74%), marbling score (choice -), and dressing percent (avg 63.2%) were not affected ($P > .10$) by pasture treatments. Supplementation increased ($P < .075$) adjusted backfat by an average of .09 in. and decreased ($P < .02$) yield grade by an average of .45% (Table 1).

Table 1. Pasture, Feedlot, Combined Performance, and Carcass Characteristics of Steers Receiving Ground Grain Sorghum Supplements when Grazing Endophyte-Infected Tall Fescue

	Pasture Grain Level, % of BW			
Item	0	.25	.5	SE[a]
Pasture Phase[b]				
Initial wt, lb	743	738	740	2
Final wt, lb	776[d]	788[d]	815[c]	8
Pasture Gain, lb	33[d]	50[cd]	75[c]	9.9
Daily Gain, lb	.53[d]	.81[cd]	1.21[c]	.16
Grain Consumption,total lb	0	105	215	
Feedlot Phase[b]				
Initial wt, lb	716	731	756	8
Final wt, lb	1236	1263	1276	16
Feedlot Gain, lb	520	532	520	
Dry Matter Intake, lb/d	22.6	22.6	23.5	.5
Daily Gain, lb	3.94	4.03	3.94	.08
Feed to Gain	5.74[d]	5.61[c]	5.96[e]	.04
Combined Total[f]				
Total Gain, lb	553	582	595	
Average Daily Gain, lb/d	2.53	2.72	2.75	.096
Concentrate Intake, lb/d	20.50	21.04	22.43	
Carcass Characteristics				
Hot Carcass wt., lb	748	763	780	14.6
Rib Eye Area, in.^{2}	13.1	12.4	12.9	.24
Adjusted Backfat, in.	.39[d]	.47[c]	.49[c]	.029
KPH, %	2.7	2.8	2.8	.11
Marbling Score[f]	5.0	5.1	4.9	.14
Dressing Percent	62.9	62.8	63.6	.36
Yield Grade	2.7[g]	3.2[h]	3.1[h]	.13

[a]Standard Error of Means.
[b]Pasture Phase - 62 days. Feedlot Phase - 132 days.
[cde]Treatment means are different, P < .10.
[f]Select = 4 to 4.9 Choice minus = 5 to 5.9.
[gh]Treatment means are different, (P < .05).

SUPPLEMENTATION OF AMMONIATED WHEAT STRAW IN WINTERING DIETS OF GESTATING BEEF COWS

T. J. Beck, D. D. Simms, R. T. Brandt, Jr., R. C. Cochran, and G. L. Kuhl

Summary

During two winters, 96 beef cows in late gestation were utilized in 60-day precalving feeding trials to evaluate supplementation for cows fed ammoniated wheat straw. Treatments included: control--mineral supplement only (C), 3 lbs milo + mineral (3M), 6 lb milo + mineral (6M), and 2.75 lb milo + .75 lb soybean meal + mineral (SBM). 3M increased ($P < .05$) cow gain over control but body condition changes were similar. 6M and SBM resulted in similar gains and body weight changes, which were higher than those of cows receiving either C or 3M. Birth weight of calves, percent cycling at the start of breeding, and percent pregnant after a 60-day breeding season were not affected by treatment. Natural protein appears to be a major limiting nutrient in cows fed ammoniated wheat straw.

(Key Words: Ammoniation, Wheat Straw, Cows, Supplementation.)

Introduction

Wheat straw is an abundant forage resource for Kansas cow/calf producers. During drought years, ammoniated wheat straw can serve as a backup feed supply for a cow herd. Prior research has shown that ammoniated wheat straw is very similar to prairie hay in feed value. Ammoniation doubles the crude protein content and increases digestibility and intake by approximately 20%.

Although improved feeding value from ammoniation is well established, appropriate supplementation of ammoniated wheat straw diets for beef cows in late gestation has not been adequately studied. Prior research has shown that the first-limiting nutrient, either energy or protein, differs depending on the supplementation scheme used. Some reproductive performance studies with cows wintered on ammoniated wheat straw have shown reduced cow and calf performance. Therefore, our objectives were to determine cow weight and body condition score changes with ammoniated wheat straw as the sole forage fed in late gestation and to evaluate the effect of either energy or protein supplementation on ammoniated straw utilization and subsequent reproductive performance of the cows.

Experimental Procedures

Big round bales of wheat straw were treated with 3% anhydrous ammonia (wt basis) in late summer in 1988 and 1989. The ammoniated wheat straw, averaging 9% crude protein, was tub-ground through a 3 inch screen and fed ad libitum. In late December of each year, 96 cows were allotted by weight, breed type, and age to 12 drylot pens with 3 pens per treatment for a 60-day feeding trial. Initial and final weights were taken on two consecutive days following an overnight shrink. Supplementation treatments consisted of: .5 lb mineral mixture formulated to meet the cow's mineral requirements (C), 3.0 lb sorghum grain + .5 lb mineral (3M), 6.0 lb sorghum grain + .5 lb mineral (6M), and 2.25 lb sorghum grain + .75 lb soybean meal + .5 lb mineral (SBM). Supplements 3M and SBM were formulated to supply the same amount of energy, whereas 6M and SBM supplied the same amount of protein. Final weights and condition scores were obtained in late February just prior to initiation of calving.

Cows were managed as one group during

and after calving on native (primarily bluestem) pasture and fed approximately 5 lb daily of 25% crude protein cubes during calving. Calves were weighed and tagged at birth. Starting approximately 40 days after the first cows calved, a blood sample was collected every 10 days and analyzed for progesterone levels to determine the number of cows cycling. That procedure was followed until the start of breeding (approximately May 20). On the day of the final blood collection, cows were weighed and condition scored. Calves were weighed and vaccinated, and male calves were castrated and implanted. All cows and calves were managed similarly on native (primarily bluestem) pastures from the start of breeding to weaning in late October. Cows were exposed to bulls for 60 days in both years.

Results and Discussion

All energy and protein supplements increased gain ($P < .01$) over mineral supplementation alone; cows fed 6M and SBM had greater gains ($P < .01$) than those fed 3M (Table 1). Cows fed SBM gained 22 lb more ($P < .01$) than cows fed 3M. Supplements 6M and SBM improved ($P < .01$) body condition score more than C and 3M. Ammoniated wheat straw intake was similar across treatments. Birth weight of calves, percent cycling at the start of breeding, and percent pregnant after a 60-day breeding season were similar for all treatments.

In conclusion, all energy and protein supplements positively influenced gain and body condition score. However, the similarity in cow performance between 6M and SBM, and the improved performance from the supplement supplying more protein (SBM) compared to one with equal energy (3M), suggest that protein was the first-limiting nutrient. The need for additional natural protein appears to be greater than the need for additional energy, despite the fact that ammoniated wheat straw alone exceeded NRC (1984) requirements for crude protein.

Table 1. Effect of Supplementation on the Performance of Cows Fed Ammoniated Wheat Straw Pre-Calving

Item	Treatment				
	C	3M	6M	SBM	SE[g]
Wt change, lb	48[a]	75[b]	101[c]	97[c]	5.82
Body condition score (1-9) change	-.21[a]	-.11[a]	.19[b]	.16[b]	.05
Ammoniated straw intake[d]	23.8	23.9	22.5	22.3	.63
Calf birth wt, lb	80	82	82	81	1.24
Calf ADG, lb	2.27	2.22	2.22	2.17	.16
Percent cycling[e]	58	67	64	59	
Percent pregnant[f]	98	100	95	94	

[abc]Means in the same row with different superscripts differ ($P < .01$).
[d]lb/head/day.
[e]At the start of breeding.
[f]At the end of a 60-day breeding season; cows palpated at weaning.
[g]Standard error.

INFLUENCE OF WATER TREATMENT ON DIGESTION DYNAMICS OF STEERS CONSUMING HIGH- AND LOW-FORAGE DIETS

D. L. Harmon and A. D. Flood

Summary

The influence of drinking water treatment (Oxion Inc., Hugoton, KS) on digestion and metabolism was evaluated in steers fed low- and high-forage diets. Water treatment did not influence digestibility of any nutrient measured nor did it influence the profile of ruminal metabolites. Water treatment did increase water consumption two- to threefold and also increased ruminal fractional water outflow (%/h) for steers fed the high forage, but not the high concentrate, diet. Increased water consumption could be a beneficial response, but it is not known if water consumption increases with management programs different than those used in the present study.

(Key Words: Steer, Water, Digestibility, Intake, Rumen.)

Introduction

A relatively new system is being marketed in Kansas for treatment of livestock drinking water. This system involves a process whereby air is passed through an electrical field and then bubbled through drinking water. This process of water treatment has been utilized for feedlot cattle and improvements in animal performance have been reported. This study was undertaken to examine the effects of water treatment on ruminal metabolism and diet digestibility in steers fed low- and high-forage diets.

Experimental Procedures

Six ruminally cannulated Holstein steers, (450 lb) were utilized in a Latin square design experiment. The treatment structure was a 2 × 3 factorial with factors being diet: 80% forage:20% grain or 80% grain:20% forage, and water treatment: control (no treatment) and low (one-half voltage) or high Oxion treatment. The forage used was good quality alfalfa hay (18% CP), and the grain mixture was composed of 44.8% cracked corn, 44.8% rolled sorghum grain, .9% dical, .23% NaCl, and .1% Vitamin A and D. Additional monocalcium phosphate and salt were added to the low forage diet to meet nutrient requirements. Animals were tethered in tie-stalls and fed in two portions daily at 0800 and 1700 h. Feed was offered at 2.5% of body weight (as fed basis) to ensure equal and complete feed consumption. Water was available free choice from individual 2-gallon tanks equipped with floats and a metered supply line to enable determination of daily water consumption.

Each period was composed of 3 weeks, 1 week for switching of diets to prevent digestive disturbance, 1 week of adaptation, and 1 week of sampling. The sampling period consisted of a 7-day total fecal collection for estimating digestibility. Three days prior to the end of each experimental period, steers were dosed intraruminally prior to the morning feeding with 200 ml of Cr:EDTA to estimate ruminal water kinetics. Samples of ruminal fluid for Cr, volatile fatty acids, and pH analyses were collected at 3, 6, 9, 12, 18, and 22 h postdosing.

Results and Discussions

Dry matter intakes were equalized, and the only differences seen in other nutrients were the result of differing chemical composition of the diets (Table 1). Similarly, the majority of differences seen in digestibility were inherent in the differing diet compositions. Neutral

detergent fiber digestibility was higher for animals receiving the low-Oxion treatment. This would suggest stimulation of fiber-digesting microorganisms.

Treated water had a higher pH ($P < .01$), a higher oxidation-reduction potential ($P < .05$), and a higher percent oxygen saturation ($P < .01$). The pH was higher simply because of the bubbling of air through the water. The oxidation-reduction potential is an indicator of oxidizing or reducing power and was high because of the higher oxygen content. These changes could possibly be induced through bubbling air alone through the water. Also, there was a diet effect on the water parameters. Oxygen saturation was higher on the 80% concentrate diet. Because dietary treatments were independent of water treatments, that may represent a chance occurrence. The most notable influence of water treatment was the effect on water intake (Table 2). Water intake increased nearly 2.5 to 3 times ($P < .01$) and was not different for the low-Oxion or high-Oxion treatment. The increased water intake did not influence ruminal volume or ruminal liquid outflow, which were lower ($P < .05$ and $P < .01$, respectively) for steers fed the 80% concentrate. However, there was a diet by water treatment interaction ($P < .05$) for ruminal fractional outflow. It increased from 5.5 to 9.5%/h on the forage diet but was unaffected on the high concentrate diet. This may relate to the greater viscosity of ruminal fluid in steers fed the high concentrate resulting in poorer marker equilibration and (or) poorer drinking water equilibration.

Ruminal pH, oxidation-reduction potential, and volatile fatty acids (Table 2) were all affected ($P < .05$) by diet, but none was influenced by water treatment. Only butyrate for steers consuming the high concentrate diet tended ($P < .10$) to be influenced by water treatment. Water treatment resulted in no measurable changes in fermentation or digestibility. The large increase in water intake seen may be a beneficial response, but additional research is needed under more typical management schemes.

Table 1. Influence of Water Treatment on Intake and Digestibility in Steers Fed High- or Low-Forage Diets

Item	Diet:	80% Forage			80% Concentrate			Probability[a]		
	Water:		Control		Low	High	Control	Low	High	SE
Diet	Water	Dt. × Wtr.								
			Oxion	Oxion		Oxion	Oxion			
Intake, kg/d										
Dry matter		6.5	6.7	6.6	6.7	6.7	6.7	.35		
Organic matter		5.9	6.1	6.0	6.4	6.4	6.5	.31	**	
Neutral detergent fiber		2.54	2.62	2.63	1.24	1.22	1.25	.17	**	
Acid detergent fiber		1.74	1.79	1.79	.63	.62	.64	.12	**	
Crude protein		1.08	1.11	1.12	.79	.78	.79	.06	**	
Starch		.86	.94	.81	3.45	3.44	3.45	.13	**	
Digestibility, %										
Dry matter		65.4	68.2	65.3	72.8	72.9	71.0	1.6	**	
Organic matter		67.4	70.3	67.6	74.0	74.0	72.3	1.6	**	
Neutral detergent fiber[b]		49.6	54.5	51.0	54.3	59.8	53.5	2.4	**	
Acid detergent fiber		49.4	53.3	51.7	51.4	53.4	48.9	2.1		
Nitrogen		69.8	71.5	69.3	63.4	63.7	59.9	1.7	**	
Starch		86.9	89.7	86.7	84.3	82.6	83.7	1.9	*	

[a]** ($P < .01$), * ($P < .05$).
[b]Low vs High Oxion ($P < .05$).

Table 2. Influence of Water Treatment on Water and Ruminal Parameters for Steers Fed High- or Low-Forage Diets

Item	Diet: Water	80% Forage Control	80% Forage Low Oxion	80% Forage High Oxion	80% Concentrate Control	80% Concentrate Low Oxion	80% Concentrate High Oxion	SE	Probability[a] Diet	Water	Dt.* Wtr.
Water pH		6.26	7.34	7.46	6.36	7.46	7.55	.10			**
Water redox, mV		-35.2	40.4	71.7	-11.2	57.5	87.1	38.8			*
Water oxygen saturation, %		.69	3.98	5.58	0.84	6.10	5.86	0.50		*	**
Water intake, liters/d		10.4	25.4	28.8	8.7	22.8	24.6	4.2			**
Ruminal volume, liters		40.1	36.3	34.8	21.4	32.2	24.3	5.3		*	
Ruminal outflow, liter/h		2.0	2.3	2.4	1.1	1.8	1.2	.3		**	
Ruminal fractional outflow, %/h		5.5	6.6	9.5	5.2	5.8	5.1	.8			*
Ruminal pH		6.33	6.37	6.44	6.10	6.12	6.12	.06		**	
Redox, mV		-172	-178	-183	-158	-156	-153	3.9		**	
Ammonia, mM		15.8	13.9	16.3	11.0	8.9	11.6	2.4			
VFA, mol/100 mol											
Acetate		69.4	68.7	69.8	60.6	60.2	59.9	1.3		**	
Propionate		18.7	19.2	18.5	24.6	26.0	27.1	1.4		**	
Isobutyrate		1.01	1.05	1.05	.89	.83	.85	.04		**	
Butyrate[b]		8.3	8.3	8.0	10.5	8.8	8.9	.57		*	
Isovalerate		1.6	1.7	1.6	2.6	2.5	2.4	.20		**	
Valerate		1.0	1.0	1.0	.0	.8	.8	.04		**	
Total VFA, mM		112.6	106.9	105.8	91.5	88.1	97.7	5.1		**	
Acetate/Propionate		3.8	3.6	3.8	2.5	2.3	2.4	.20		**	

[a]**(P < .01) *(P < .05).
[b]Control vs. Low and High on 80% concentrate diet (P < .10).

PREDICTING NUTRITIONAL COMPOSITION OF CORN GRAIN USING NEAR INFRARED REFLECTANCE SPECTROSCOPY

G. Garcia-Lagombra and L. H. Harbers

Summary

Corn grain samples collected over several years were used to develop equations for dry matter, crude protein, crude fiber, and ether extract (crude fat). Two computer models were used to select samples having a range of spectra (presumably a range of nutrient values) for developing calibration equations. Both methods selected an unexpectedly small number of samples; however, only the prediction of crude fiber appears questionable. Although coefficients of determination values are expected to be low with a small number of samples, standard errors of validation and prediction are consistently lower than those of standard (AOAC) methods, suggesting that the technology is reliable for nutrient analysis of corn grain.

(Key Words: Corn Analysis, Near Infrared Spectroscopy.)

Introduction

Near Infrared Reflectance Spectroscopy (NIRS) has been widely used for rapidly estimating nutritional composition of cereal grains and feedstuffs. Wet chemistry procedures are lengthy and expensive, so researchers sought ways to reduce cost and analysis time. Because corn grain is of prime importance for ration formulation, a rapid and reliable method for nutritional composition is necessary. NIRS has shown great potential to predict nutritional composition when an appropriate set of calibration samples is chosen.

Although NIRS is high in initial cost and requires trained personnel, it is capable of analyzing many samples in a short time, non-destructively, and with little or no use of supplies or chemicals.

Experimental Procedures

Two hundred ninety-nine corn grain samples from three consecutive years (1987, 1988, and 1989) were obtained from Peterson Laboratories in Hutchinson, Manhattan Milling Company, and Manhattan Co-op. Those samples covered most of Kansas, as well as several areas of Texas and Oklahoma.

The samples were stored at room temperature, ground in a cyclone-type (UDY) mill, and then frozen. Later, they were thawed and scanned in duplicate with a tilting filter NIRS (Pacific Scientific 4250). The spectra of each sample were averaged, then stored on computer disks for further manipulation.

Samples with unique spectra were chosen by one of two subset programs. The first method picks a sample and eliminates those that are similar. The second method picks a pair of samples and eliminates the closest neighbors. Samples from both sets and additional samples chosen at random for validation were analyzed for dry matter (DM), crude protein (CP), crude fiber (CF), and fat or ether extract (EE) by standard (AOAC) chemical methods. The AOAC data were matched with NIRS spectra to develop and validate NIRS equations.

Results and Discussion

From a total of 229 samples, only seven calibration samples were selected by method 1 and 11 by method 2. Only one sample was found in both sets. This selection process indicates a great deal of similarity among

spectra of the corn samples. When samples are similar in composition, many samples need to be collected to produce reliable calibrations. A single equation was chosen for each nutrient based on a set of statistical criteria. Dry matter information was found at wavelength 2180, crude protein at 1956 and 2078, crude fiber at 2172, and ether extract at 2236.

Table 1 summarizes the standard errors of calibration and validation. The data suggest that chemical values agree fairly well with calibration scans. Only dry matter and ether extract values were satisfactory with respect to validation samples.

Statistical comparisons of NIRS and AOAC values (Table 2) indicate very small variations between the two methods, which strongly suggests that the equations are adequate. The standard deviation values (SD) for NIRS values are consistently smaller than those for laboratory values, again suggesting that the equations are adequate but that samples with greater variation than those presently available would improve them.

Table 1. Means, Standard Errors and Correlations of Corn Regression Equations

				Calibration		Validation		
Variable	No.	Range, %	Mean, %	SE[a]	R^{2} [b]	SE[a]	R^{2b}	Method
DM	6	85.66-92.00	89.69	0.424	0.899	2.974	0.995	1
CP	10	8.18-10.77	9.46	0.303	.885	0.949	0.213	2
CF	7	0.52-1.58	1.05	0.171	.656	0.131	0.286	1
EE	7	3.42-5.25	4.57	0.196	0.860	0.209	0.998	1

[a]SE = standard error.
[b]R^2 = coefficient of determination.

Table 2. Comparison of NIRS Predicted Values vs. Laboratory Analyzed Values of Corn

Variable	No. Values	Mean, %	SD[a]	R[b]	R^{2c}
DM Lab	24	89.41	2.070	0.370	0.137
DM NIRS		89.26	0.721		
CP Lab	22	9.37	0.700	0.855	0.731
CP NIRS		9.42	0.625		
CF Lab	24	1.09	0.199	0.508	0.258
CF NIRS		1.11	0.140		
EE Lab	24	4.55	0.595	0.738	0.544
EE NIRS		4.59	0.448		

[a]SD = standard deviation.
[b]R = correlation coefficient.
[c]R^2 = coefficient of determination.

INDEX OF KEY WORDS

Indexer's note: The pages identified here are the first pages of each article that uses the listed key word.

BIOLOGICAL VARIABILITY AND STATISTICAL EVALUATION OF DATA

The variability among individual animals in an experiment leads to problems in interpreting the results. Animals on treatment X may have a higher average daily gain than those on treatment Y, but variability within the groups may indicate that the difference between X and Y is not the result of the treatment alone. You can never be totally sure that the difference you observe is due to the treatment, but statistical analysis lets researchers calculate the probability that such differences are from chance rather than from the treatment.

In some articles, you will see the notation "P<.05." That means the probability that the observed difference was due to chance is less than 5%. If two averages are said to be "significantly different," the probability is less than 5% that the difference is due to chance – the probability exceeds 95% that the difference is true and was caused by the treatment.

Some papers report correlations – measures of the relationship between traits. The relationship may be positive (both traits tend to get larger or smaller together) or negative (as one gets larger, the other gets smaller). A perfect correlation is either +l or -1. If there is no relationship at all, the correlation is zero.

You may see an average given as 2.5 ± .1. The 2.5 is the average; .l is the "standard error." That means there is a 68% probability that the "true" mean (based on an unlimited number of animals) will be between 2.4 and 2.6.

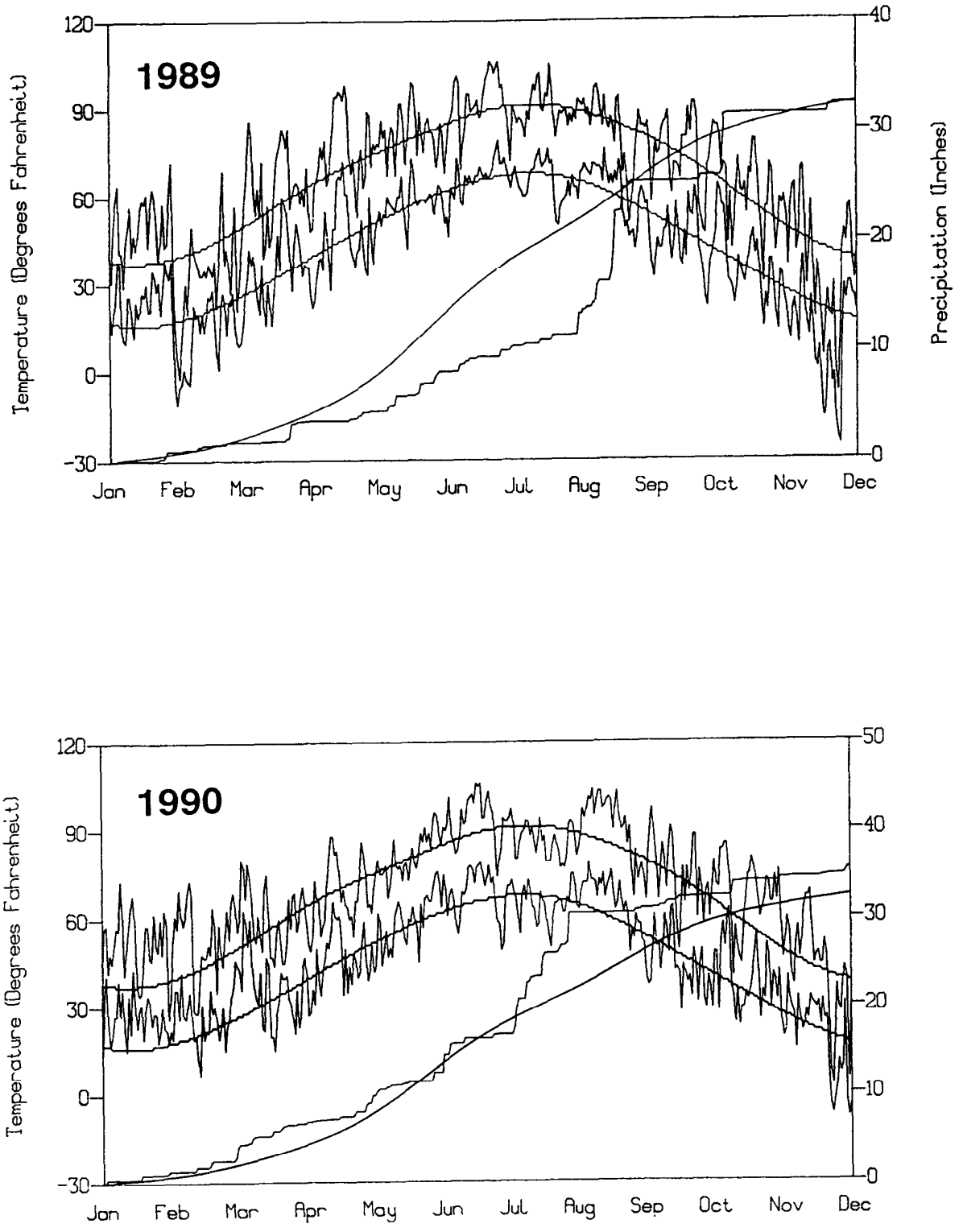
"Standard deviation" is a measure of variability in a set of data. One standard deviation on each side of the mean is expected to contain 68% of the observations.

Many animals per treatment, replicating treatments several times, and using uniform animals all increase the probability of finding real differences when they actually exist. Statistical analysis allows more valid interpretation of the results, regardless of the number of animals in an experiment. In the research reported herein, statistical analyses are included to increase the confidence you can place in the results.

WEATHER DATA, 1989-1990

On the following page are graphs of the 1989 and 1990 Manhattan weather. They were produced by the Kansas Agricultural Experiment Station Weather Data Library. The smooth line that starts in the lower left corner of each graph is the normal accumulated precipitation since January 1. The rough line starting in the lower left corner represents actual accumulated precipitation. A long horizontal section of that line represents time during which no precipitation fell. A vertical section represents precipitation. The other two smooth lines represent average daily high and low temperatures, and the rough lines represent actual highs and lows.

These graphs are included because much of the data in this publication, especially data on animal maintenance requirements and forage yields, can be influenced by weather. Weather graphs have been included in Cattlemen's Day publications for the past 6 years.



Graphical Weather Summary for Manhattan, Kansas

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