THE EFFECT OF TEXTURED AND PELLETED CONCENTRATE ON MILK COMPONENT PRODUCTION

by

WENDY CHRISTINE GARDNER

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ABSTRACT

Two trials were conducted using Holstein dairy cattle to determine if any difference in milk yield, milk composition and animal food intake occurred when cows were fed either a textured or pelleted concentrate. In the textured concentrate the grain portion was steam flaked with the remainder of the ingredients being pelleted. Both trials used a change-over design where all animals received both diets. In the first trial the animals were classified according to milk production level and were fed textured and pelleted concentrates with alfalfa cubes as the forage source. Cow, period, production level and treatment effects were studied. It was found that animals fed textured concentrate had a significantly ($P<0.05$) higher milk fat percentage, higher rumen acetate and lower rumen propionate than those fed the pelleted concentrate.

In the second trial, textured and pelleted concentrates were fed with a corn:grass silage mixture as the forage. Animals that were fed textured concentrate had a significantly higher silage intake ($P<0.05$) and concentrate intake ($P<0.01$) but a significantly lower ($P<0.01$) milk yield. Milk fat percentage was found to be significantly higher ($P<0.01$) with the textured feed, although no significant difference was found when fat yield was compared. Milk protein yield was significantly ($P<0.01$) higher with the pelleted feed while both rumen pH and RBC

were lower (P<0.01). Concentrate processing had no significant effect on rumen volatile fatty acid concentration.

In the third trial, the degradation characteristics of dry matter (DM) and protein of textured and pelleted concentrates and a corn:grass silage mixture were determined. Concentrates were incubated in nylon bags for up to 72 h and the silage for up to 96 h in the rumen of animals fed an alfalfa and grass hay mixture along with a 16% protein dairy concentrate. The pelleted concentrate had a higher (P<0.01) readily soluble dry matter fraction, readily soluble protein fraction (P<0.01), and effective protein degradability (P<0.05) than the textured concentrate.

The results indicate that the feeding of textured concentrate resulted in an increase in milk fat percentage. However, in trial two, feeding textured concentrates did not change milk fat yield while pelleting increased protein yield. The results from trial three indicate that the higher level of heat and moisture involved in steam flaking may act to protect the protein fraction and to decrease the readily degradable dry matter fraction of the concentrate.

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INTRODUCTION AND OBJECTIVES

INTRODUCTION

The current feeding practices in the dairy industry involve feeding fairly high levels of concentrates in conjunction with a variety of different forages sources. The forage source fed depends on such factors as costs, location and land base. The type of concentrate fed is of importance as it can have an effect on such factors as intake, milk yield and milk component production. Currently, in British Columbia, many producers are feeding textured concentrates to their dairy herds and it is believed that textured concentrates may lead to increased milk fat production compared to the feeding of pelleted concentrates. With textured concentrates the grain portion of the ration is steam flaked while the remainder of the ingredients are pelleted. Also, the processing of textured concentrates involves higher levels of heat and moisture than those used in pelleting concentrates.

British Columbian producers are currently paid on a milk fat plus constant formula in which returns are based on milk yield and milk fat percentage. However, there is a move being made towards multiple component pricing. With multiple component pricing the producer is paid on the basis of more than one milk component. Therefore, if multiple component pricing is implemented, it will be important for producers to look at the effect of such factors as processing of concentrates on milk yield and milk component production.

OBJECTIVES

The overall objectives for this research study are:

1. To determine if there is a difference in milk yield, composition or ration utilization when either textured or pelleted dairy concentrates are fed.

2. To determine the intake characteristics of pelleted and textured dairy concentrates with dairy cattle at different levels of production.

3. To determine if differing forage sources effect the results obtained from textured or pelleted dairy concentrates.

4. To compare the ruminal degradation characteristics of textured and pelleted dairy concentrates.

CHAPTER ONE

LITERATURE REVIEW

CEREAL PROCESSING

i. Introduction

Today, cereal grains provide the major source of energy in compound feeds fed to ruminant livestock (Hutton and Armstrong 1976) and therefore, there has been a tremendous increase in development and application of methods for processing and preparing feed grains for feeding ruminants (Hale and Theurer 1972). In dairy cattle, it has been shown that digestibility can be improved by feeding processed versus whole cereal grains (Orskov 1981). Mandell et al. (1988) demonstrated that feeding whole barley to cattle resulted in up to 50% of the total grain dry matter remaining undigested. Thus, in general, some form of processing is considered advantageous for cereal grains, although there are certain cases were processing is not essential such as when whole grains are chemically treated (Hale and Theurer 1972; Hutton and Armstrong 1976; Orskov et al. 1978).

Processing of cereal grains results in changes in the physical form and chemical composition of those grains and factors such as temperature, time of processing, cereal type and moisture all have significant effects (Hutton and Armstrong 1976). Grain processing can basically be broken down into hot and cold processing and further sub-divided into wet and dry processing (Hutton and Armstrong 1976). Both pelleting and steam flaking are classified as hot and wet processing although more moisture and higher levels of heat are used in steam flaking (Hale and Theurer 1972). Pelleting is the agglomeration of small particles into larger particles by means of a mechanical process involving moisture, heat and pressure (McEllhiney 1985). Two primary reasons for pelleting are to improve feed efficiencies and handling characteristics. Feed efficiency is increased as the moisture, heat and pressure cause components in the feed to gelatinize so that animals can better use the finished feed product and also, the pelleting reduces separation of the ingredients, ensuring animals are getting a balanced ration. Handling characteristics are improved as flowability is increased versus meal feeds and more feed can be stored in a given space (McEllhiney 1985).

Textured concentrates are feeds in which the grain component is steamed and rolled while the remainder of the ingredients are formed into pellets. In textured feeds the grain is subjected to high moisture steam for a sufficient length of time to raise the moisture content to 18 to 22 % (Hale and Theurer 1972) and may cause the grains to reach temperatures of 210^{0}F (McEllhiney 1985). This steam addition, combined with the rolling, leads to gelatinization of the starch granules within the grain husk. As well, the husk is cracked to give the rumen microbes access to the contents but still remains basically intact which may lead to rumen stimulation (Nordin and Campling 1976).

ii. General effects of processing

One of the main effects of processing cereals is the alteration of the starch fraction. Animal digestion studies have shown that the digestion of the starch portion is markedly improved by proper processing of the grains (Hale and Theurer 1972). In general, starch in heat/moisture processed grains is digested to a greater extent in the rumen than starch in minimally or unprocessed grains. This is because certain processing methods lead to disruption of the protein matrix of the endosperm, thus permitting easier enzymatic access to the starch granules (Hale 1973). As well, gelatinization, or loss of birefringence, occurs when enough energy is applied to break hydrogen bonds in the crystalline region of the starch granule (Rooney and Pflugfelder 1986) causing swelling of the granule and therefore greater susceptibility to amylolytic attack by both ruminal microbial and pancreatic enzyme sources (Theurer 1986). Theurer (1986) stated that in vitro and in situ studies suggest that much of the increase in ruminal starch fermentation with steam flaking is due to changes in starch granular structure, which produces additive effects beyond those of decreasing particle size.

For gelatinization to occur, water is critical. Shaw et al. (1960) showed that the application of moist heat to starch brings about hydration of the starch causing it to be digested more rapidly. Heating the grain without the addition of moisture actually decreased the rate of digestion. Feeds that have undergone gelatinization may lead to an increase in ruminal starch digestion which in turn may cause an increase in propionate production (Murphy et al. 1982; Nocek and Tamminga 1991). However, increasing starch or other rapidly fermentable carbohydrates in the diet of ruminants to a high level leads to a reduction in fiber digestion. This reduction may be caused through changes in substrate utilization by rumen micro-organisms, reduced numbers of cellulolytic organisms, lowered pH and changes in digesta passage rates (Salsbury et al. 1961; Shriver et al. 1986). Porter et al. (1972) and Counotte (1981) also found that high levels of easily fermentable substances caused a decrease in pH and an increase in volatile fatty acids (VFA's) and lactate production in the rumen fluid resulting in a lower cellulolytic activity of the microbes in the rumen. As well, this lower cellulolytic activity leads to a decrease in degradation of cell wall constituents, lowering the rate of breakdown of fibrous particles in the reticulorumen and may therefore, decrease intake (Steg et al. 1985).

The effect of heat on processing cereal grains is also important as many studies have indicated that processing with heat alters digestibility (Hutton and Armstrong 1976). Heat denatures proteins, and potentially complexes carbohydrates and proteins; this effect on protein may play a role in determining the overall feeding value of processed grains (Gaylean and Malcolm 1991). Heat processing may also result in reducing the ruminal degradation of the protein, resulting in a greater flow of feed versus microbial protein when heat processed grains are fed.

iii. Other effects of starch

Rates of fermentation vary between different sources of carbohydrates. Soluble sugars have the highest rate, followed by starch having an intermediate rate that varies with the type of starch. Cell wall constituents have the lowest rate of fermentation, which does not commence until a lag phase occurs (Johnson 1976; Sutton 1980). Yamdagni et al. (1967) found that both the quantity and type of starch in the diet seem to be an important factor in influencing the fat content of milk with a level of 36% corn starch in the concentrate resulting in a depression of milk fat content while a level of 33.5% starch from other feeds, but only 15% corn starch, maintained the milk fat test. Theurer (1986) stated that although starch utilization may be markedly enhanced by proper processing the extent of improvement is affected by the grain source and method of processing with sorghum having the most improvement, followed by corn and then barley with little improvement. Nocek and Tamminga (1991) found that the site of starch digestion depends upon the type and degree of processing, however, the effect of processing on starch digestion in the small intestine is not well documented (Theurer 1986). There is evidence to indicate that the site of digestion of the starch fraction may have an impact on milk yield and composition. Robinson and Kennelley (1989) suggest that shifting the site of starch digestion from the rumen to the small intestine results in a greater energetic efficiency of starch digestion and utilization. A study done by Poore et al. (1989) compared dry rolled and steam flaked milo at similar starch intakes and found that steam flaking increased ruminal starch digestion as well as total tract digestibility by 17 percentage units and increased milk yield by 3.4 kg. Herrera-Seldana and Huber (1989) found that animals fed diets with higher rumen degradable starch had the highest milk yields even though starch delivery to the lower gut was similar among diets. However, in a study by Oliveira et al. (1990), animals were fed diets varying in amounts of ruminal degradable starch and post ruminal starch and no differences in milk production were found. Nocek and Tamminga (1991) concluded that overall, production studies still yield no clear evidence that postruminal starch digestion enhances milk yield or changes composition, although there is some indication that postruminally digested starch may be used more efficiently for milk synthesis than starch digested in the rumen.

iv. Effects of processing on corn and barley

Studies done on the effects of processing corn have been conflicting. Hale and Theurer (1972) suggest that whole shelled corn should be utilized in concentrate rations in order to obtain optimum utilization. However, Buckley and Devlin (1983) found little benefit in processing rye, barley and oats, but found corn digestibility may be improved substantially by reconstituting ground corn. Galyean and Malcolm (1991) also concluded that barley and wheat do not seem to respond to processing methods that induce gelatinization to as great a degree as corn and milo do, although research findings are still not in total agreement on this point. Hale (1973) also stated that corn and sorghum grain have a greater improvement in utilization due to processing than do wheat and barley. Concerning the possible advantages of heat processing corn, Armstrong (1972) concluded that, although evidence was by no means unequivocal, there was some reduction in feed intake without any decline in daily gain suggesting an improvement in feed efficiency likely due to a slight increase in digestibility. Hutton and Armstrong (1976) found that heat processing of corn decreased acetate and butyrate and increased propionate resulting in a decline of milk fat content.

The different methods of processing barley have also led to conflicting results. Orskov (1979) stated that the low ruminal digestion of whole barley by cattle necessitates physical processing of the grain to ensure maximum utilization. Armstrong (1972) found the observations in the literature between cold and heat processed barley for beef cattle was contradictory, although on balance, there were some advantages in processing of the grain. However, Waldo (1973) stated that very little variation in digestibility occurs from using different processing methods with barley, as barley starch is so highly digested in the rumen (94%). Grimson et al. (1987) found that steam processing of barley did not improve feedlot performance of cattle over that found with dry rolling while Parrott III et al. (1969) found that steam flaking as compared to dry rolling barley did not improve digestibility of the proximate fractions or the availability of the TDN except when the TDN of the barley was low. In contrast to this, Gaylean and Malcolm (1991) found barley to be used most efficiently by cattle when some type of heat/moisture process, such as steam rolling, was used. Also, Moran (1986) compared whole to steam rolled barley and the results showed steam rolled barley had higher starch and dry matter digestibilities as well as increasing the total volatile fatty acid (VFA) concentration. Zinn (1993) found steam processing in addition to rolling improved the net energy for maintenance value of barley from 2.8 to 7.0%. He suggested that this may be attributed to enhanced ruminal N efficiency, decreased ruminal methane loss and increased total tract starch digestibility. Hale and Theurer (1972) also agreed that barley should be processed by some method. However, in an extensive review on the feeding value of barley, Newman and McGuire (1985) concluded that with regard to ruminants barley responds little to extensive processing (beyond rolling) and that variety differences can have an impact on performance (likely due to bushel weight or composition differences). However, some type of processing of barley seems desirable to reduce the incidence of bloat often observed in cattle fed high grain diets based on whole barley (Engstrom and Mathison 1989).

v. Pelleting versus steam flaking

There have been many studies done on the different processing methods and their effects on cereal grains and concentrates, but few studies have been carried out comparing the digestibility of steam flaked grains as opposed to pelleted grains and there effects on milk composition and production. A study done by Hawkins et al. (1963) comparing pelleted grain to meal found that pelleting reduced milk fat percentage and caused a decrease in the molar percentage of butyrate and acetate while increasing propionate. They hypothesized that the changes in VFA concentrations were likely due to the changes in the starch caused by pelleting. This is in agreement with Kempton and Hiscox (1983) who found that pelleting did disrupt the protein matrix surrounding the starch granules in the endosperm of maize and sorghum as indicated by increased dry matter degradation. Studies conducted by Bishop et al. (1963) and Yamdagni et al. (1967) also compared pelleted grains to meal and found that pelleting led to an increase in milk yield and a decrease in fat percentage. Variable results were found in regard to intake of pellets when compared to meal with either no difference in intake occurring (Bishop et al. 1963; Yamdagni et al. 1967) or a slight reduction in intake (Hale and Theurer 1972).

In looking at steam flaking, many studies have been carried out comparing steam flaking to other processing methods, mainly dry rolling, and the effects caused by steam flaking different cereal grains, some of which were discussed previously. Papasolomontos and Wilkinson (1976) found steam flaking decreases nitrogen solubility in barley and maize. Steam flaking appears to alter the ruminal digestion of both protein and starch through heat or solubilization effects (Owens and Bergen 1983) and steam flaking consistently improves the digestibility of starch by dairy cattle fed corn or sorghum based diets over whole, ground or dry rolled processes (Theurer 1986). Focant et al. (1990) also found that steam flaking gelatinized the starch and decreased the nitrogen solubility, resulting in an increase in the supply of amino acids to the intestine. As well, both Phillipson (1952) and Shaw et al. (1960) reported that steam flaking of corn reduced the ratio of acetate to propionate. Brown et al. (1970) found digestibility of various feed components and milk production to be similar for pelleted and steam processed and rolled grain rations. The response of intake to steam flaking has also been variable. Grimson et al. (1987) found no difference in dry matter intake between dry rolled and steam flaked barley fed to steers. While Hale et al. (1966) found that steam flaking both milo and barley increased feed intake over that of dry rolling. Hale and Theurer (1972) also confirmed this observation.

One difference between pelleting and steam flaking is that higher heat and moisture are involved in steam flaking and thus may lead to greater gelatinization of the starch fraction. Harbers (1975) found that pelleting causes a lesser degree of gelatinization of starch than extrusion. Also the site of digestion of the starch fraction may be affected which could have an effect on milk production and composition, although the results on this are still conflicting (Nocek and Tamminga 1991). Another difference between pelleting and steam flaking is that with steam flaking the husk is still left mainly intact and thus may stimulate the rumen more than grain which has been pelleted.

MILK COMPOSITION

i. Introduction

Milk composition is affected by many factors such as environment, genetics, hormonal balance, physiological state, diet, management and feeding program (Oldham 1984; Coppock 1985). Environment refers to the aspects such as temperature and humidity while management includes such factors as handling procedures, milking practices and health management. The milk composition of the individual cow undergoes periodic fluctuations and characteristic changes over the course of a lactation (Maynard et al. 1979). It has been shown that as a normal decline in yield occurs, the percentage of fat rises, as does the protein to a lesser degree, and the lactose declines slightly (Maynard et al. 1979; Collier 1985).

The level of milk production in dairy cows is highly related to the energy and protein intake, as long as the genetic production potential of the animal is not limiting. Milk composition, however, will be dependant on the availability of sufficient amounts of precursors needed for the production of fat, lactose and protein (Steg et al. 1985; Thomas and Chamberlain 1988). The precursors of milk fat are acetate, triglycerides and B-hydroxybutyrate (Maynard et al. 1979) while the precursors of lactose are glucose, propionate and glucogenic amino acids and for protein they are amino acids (Steg et al. 1985). As well, propionic acid, a glucose precursor, tends to be antiketogenic and thus acts to lessen B-hydroxybutyrate in the blood (Maynard et al. 1979).

The amounts of these precursors present and their ratios will be affected by the type, amount and method of processing of the feed. For example, increasing the energy intake of dairy cows by increasing the consumption of starchy concentrates tends to increase the level of milk production but also decreases the ratio of acetic to propionic acid in the rumen and thus leads to a decrease in milk fat (Broster et al. 1979; Sutton 1988). It is well documented that digestion of fiber in the rumen will promote acetic acid production while feeding high levels of soluble carbohydrates will increase propionic acid production (Steg et al. 1985).

ii. Milk pricing formulas

In the past milk pricing systems in most of North America were based on the fat plus constant formula (fat differential) in which payment is based mainly on fat content. Now, however, there is a move being made towards multiple component pricing (MCP) with Provinces such as Ontario and Quebec already operating under this new system. In milk pricing the main objective is to have the price of the milk components accurately reflect the market value. The disadvantage of the current pricing system in British Columbia is that, although it results in the lowest differences in fluid milk costs, it also causes important differences in milk costs for other dairy products, both between different production plants and season (Emmons et al. 1990a).

With the MCP formula milk is priced on the basis of more than one component: such as fat and protein; fat and solids non-fat (SNF); or fat, protein, lactose and minerals (Emmons et al. 1990a). MCP is advantageous in that milk varies seasonally, regionally and between herds, and also that yields of dairy products such as butter or cheese are directly dependant on the content of fat, protein and lactose in milk (Emmons et al. 1990a). As well, Emmons et al. (1990b) showed that a product-yield pricing system resulted in the lowest milk cost differences among plants and regions. They also demonstrated that milks differing by as little as 0.1% in fat, protein or lactose could have important effects on costs of milk per unit of products.

Therefore, a change in the pricing formula used for milk will also effect the composition of milk the farmers want from their cattle. Currently, only the level of milk fat along with milk yield is used in the British Columbia pricing formula. However, with a move towards MCP other components such as protein and lactose will become more important and the past trend towards high fat production will likely decrease. It is therefore both relevant and important to look at the effect that nutrition can have on milk production and how such factors as the method of processing concentrates may effect milk yield and composition.

CHAPTER TWO

TRIAL ONE

EFFECT OF TEXTURED AND PELLETED CONCENTRATES FED WITH ALFALFA CUBES ON INTAKE AND MILK COMPONENT PRODUCTION

INTRODUCTION

Trends in dairy cattle feeding have been toward a heavy use of concentrates with limited roughage (Wing and Wilcox 1963). This move toward increased concentrate feeding has resulted in increased interest in the processing and preparation of the grain component of the ration in order to get maximum performance from them (Hale and Theurer 1972). It has been established that grains should usually be rolled or milled before feeding them to livestock (Nordin and Campling 1976), although the exact process which will be the most advantageous is still an important question. Studies done on the various feed processing methods have shown that feed processing does effect livestock production and that there are significant interactions between the type of cereal fed, the composition of the diet, the production situation, the extent of processing and the nature of the processing technique (Hutton and Armstrong 1976). In general, processing is associated with improvements in the efficiency of nutrient utilization by ruminal microorganisms and in the total tract (Nocek and Tamminga 1991). Processing which involves the use of moist heat will lead to gelatinization of the starch granule (Hale and Theurer 1972; McEllhiney 1985) making it more accessible to enzymatic digestion and thus increase ruminal starch digestion, as long as the formation of indigestible starch-protein complexes does not occur (Thorne et al. 1983).

Of particular interest at the current time, is the comparison of textured and pelleted dairy concentrates. Textured grains are those that contain the cereal in a steam rolled form with the remainder of the concentrate being pelleted while in pelleted concentrates all the components are ground and formed into pellets. It has been shown that pelleting of concentrate is beneficial in that it tends to decrease waste and reduce dust (Hutton and Armstrong 1976), minimize spoilage (Orskov 1981), improve feed efficiency over meal (McEllhiney 1985), and in addition, provide a means for even distribution of protein and minerals. Trials done comparing a pelleted concentrate to a ground meal showed a reduction in milk fat percentage (Hawkins and Little 1967). It is felt that the use of textured feeds enhances intake and maintains the roughage characteristics of some cereal grains and may therefore lead to an increase in milk fat. However, at present, few studies have been done directly comparing pelleted and textured dairy concentrates.

The objective of this experiment was to determine if there was a difference in milk composition when the concentrate portion of the ration was textured compared to when it was pelleted.

MATERIALS AND METHODS

Diet

A dairy concentrate based on barley and canola meal was formulated and processed as pelleted and textured. In the pelleted concentrate all of the components were ground and pelleted while in the textured concentrate the barley was steam rolled and the remaining ingredients were ground and pelleted (Table 2-1 and 2-2). The temperature of the pellet mill conditioning auger was at approximately 70^0C while the temperature of the roller mill conditioning chamber was at approximately 85^0C. The same batch of barley was used in both concentrates (Table 2-2). The rolled barley and pellets in the textured concentrate were mixed together prior to being shipped to UBC from the Agriculture Canada feed mill in Agassiz where the feeds were prepared.

Animals

The concentrates were fed to a group of 29 Holstein cows along with alfalfa cubes at three different ratios depending on their milk production level: animals three weeks post-partum or producing in excess of 36 kg d^{-1} of milk were classified as high production animals, animals between 27 and 36 kg d^{-1} of production were classified as medium production animals and animals producing less than 27 kg d^{-1} of milk were classified as low production animals. The ratios of alfalfa cubes to concentrate for the three groups of animals were as follows: 40/60 for high producing animals, 45/55 for mid-producing animals and 50/50 for low producing lactation animals. The animals were divided in this manner to determine if the responses were the same at different production levels.

Treatments

The experiment was run in a change-over design in which all animals received both diets. Within each production level, the animals were assigned randomly to one of the two treatment groups with 13 in one group and 16 in the other. Each period was 28 days in length. On day 4 of the first period, four of the animals were brought in from the Agassiz Research Station and added to the original 25 animals.

Data Collection

Feed intake and milk production were recorded daily. The daily feed intake was determined with the use of Calan doors. The animals were weighed during the first and fourth week of each period. Milk samples, representing 4 consecutive milkings, were taken for composition analysis and rumen samples by stomach tube were taken on the last day of each period. Feed samples were collected weekly through out both periods and then ground through a 2 mm screen and a composite sample was taken from this for each feedstuff and stored in a plastic bag for analysis.

Analysis

The milk samples were sent to the B.C. Ministry of Agriculture and Food Marketing Branch and analyzed for fat, protein and lactose using an Infra Red Milk Analysis system (Multispec Ltd., Brampton, Ont). The composite feed samples of the alfalfa cubes and pelleted concentrate were analyzed for protein, ADF and NDF, however, due to a loss of sample, analysis could not be carried out on the textured concentrate. Protein analysis was done using the wet ash method of Parkinson and Allen (1975) followed by the Technicon Auto Analyzer while ADF and NDF analysis were done using both the acid detergent fiber method and neutral detergent fiber method of Waldern (1971). Rumen samples were sent to the Agriculture Canada laboratory at Agassiz and analyzed for volatile fatty acid distribution using the procedure outlined by Erwin et al. (1961) on the gas chromatograph (Varian Model 3700) which was equipped with a capillary 15m DB wax-5 column (J+W Scientific, Folson, Calif.).

Data were analyzed using the GLM analysis of variance procedures of SAS (Statistical Analysis Systems 1985). Cow, period, level of production and treatment were included as main effects in the model.

RESULTS

Concentrate Processing Effects

A significant difference ($P<0.05$) was found in the fat percentage of the milk with the animals fed the pelleted concentrate having a significantly ($P<0.05$) lower milk fat yield and percentage than that of the animals fed the textured concentrate. Also, fat efficiency was significantly ($P<0.01$) lower for animals fed the pelleted concentrate (Table 2-3).

There was also a significant ($P<0.05$) difference between textured and pelleted feeds in both acetate and propionate concentration. The rumen fluid of animals receiving the textured feed had a higher acetate concentration than that of the pelleted (61.90 versus 59.70 molar %) and a lower propionate concentration (26.08 versus 29.57 molar %) (Table 2-4). A trend ($P<0.1$) was observed in the case of the acetate : propionate and acetate + butyrate : propionate ratios. Both ratios increased when textured concentrate was fed.

Period Effects

A significant difference ($P<0.01$) in milk production was found between periods with period 1 having a higher production of 4.7 kg d^{-1} (Table 2-5). As well, both fat and protein yield significantly ($P<0.01$) decreased from period 1 to period 2. There was also a significant difference ($P<0.05$) in average daily gain between periods with period 2 being higher than period 1. Feed ($P<0.01$), concentrate ($P<0.05$), fat ($P<0.05$) and protein ($P<0.05$) efficiencies were all significantly higher in period 1 versus period 2 (Table 2-5).

Level of Production Effects

Significant differences ($P<0.05$) were found in the amount of concentrate consumed, the amount of milk produced and in the percentage and yield of protein and fat found in the milk produced between the three levels of production. There was a significant difference ($P<0.05$) between the low and middle production groups and also between the low and high production groups in concentrate consumption. Milk production was highest for the top producing animals and declined for each subsequent production group. Lactose percentage remained fairly constant, but milk fat and protein percentage decreased while milk fat and protein yield both increased as level of production increased (Table 2-6). There was no significant interaction found between the level of production and the response in milk composition between the textured and pelleted concentrates. Feed, concentrate and protein efficiencies were all significantly ($P<0.01$) effected by level of production (Table 2-6).

A significant difference ($P<0.05$) was found between the low and the medium and between the low and the high levels of production in acetate, propionate, butyrate and isobutyrate and in the ratios of acetate : propionate and acetate + butyrate : propionate (Table 2-7).

Other Interactions

The concentrate consumption in kg d^{-1} was found to have a significant interaction ($P<0.05$) between period and level of production, with high producing cows in period 1 not consuming as much concentrate as in period 2 while low producing cows in period 1 consumed more concentrate than did the low producing cows in period 2. Also, a significant interaction ($P<0.05$) was found between average daily gain and level of production with all levels of production having lower rates of gain in period 1 compared to period 2 and the high producing animals having the lowest rate of gain in period 1 but the highest rate of gain in period 2.

DISCUSSION

Fat and protein are expressed both in terms of percentage and on a daily yield basis. As B.C. dairy farmers are currently paid on the basis of fat percentage and wish to remain within a certain volume of milk production to avoid penalties for overproduction, percentage is currently a better indicator for producers.

Concentrate Processing Effects

As textured concentrate requires both high levels of heat and moisture during processing (McEllhiney 1985) it is expected that increased ruminal starch digestion will occur causing an increase in propionate production (Murphy et al. 1982; Nocek and Tamminga 1991). A study by Poore et al. (1989) found that steam flaking versus dry rolling increased ruminal starch digestion as well as total tract digestibility by 17% and milk yield by 3.4 kg. The current study found that the feeding of textured concentrate led to higher levels of acetate concentration and decreased propionate concentration compared to the feeding of a pelleted concentrate. This may be due to the formation of indigestible starch-protein complexes (Thorne et al. 1983) or due to the fact that with steam flaking grain the husk remains intact and thus may lead to more rumen stimulation (Nordin and Campling 1976). As well, an increase in fiber may have occurred as steam flaking may increase ADF by inducing artifact lignin formation or causing separation of the grain kernel into components (Malcolm and Kiesling 1993).

Animals fed the textured diet showed a substantially higher percentage of milk fat (approximately 0.78 milk percentage units) and milk fat yield than those on the pelleted diet. This increase likely resulted from the increased acetate levels of the animals fed the textured concentrate as rumen acetic acid is one of the main precursors of milk fat (Sutton 1988; Anderson et al. 1985). As well, the efficiency calculations show that the textured concentrate was used more efficiently for milk fat production than the pelleted concentrate.

Period Effects

Milk production was higher in period 1 compared to that of period 2 because as an animal progresses in her lactation, her milk yield will decline and both fat and protein percentage will tend to increase (Appleman et al. 1985). The decrease in both fat and protein yield from period 1 to period 2 is to be expected as yield is calculated based on milk production so the decrease in milk yield in period 2 leads to a decrease in milk component yields. The weight loss in period 1 and gain in period 2 is also expected as many of the animals in period 1 were just reaching peak lactation but had not yet reached peak intake and thus were using their body reserves causing a decrease in body weight (Collier, 1985). The increased feed, concentrate, protein and fat efficiencies in period 1 versus period 2 are to be expected as efficiency is calculated based on yield and consumption and in period 1 the milk, fat and protein yields were all significantly higher than in period 2.

Level of Production Effects

Concentrate consumption was lowest for low producing cows because they received a lower amount of concentrate than did the mid and high production animals. Also, the difference among all three production groups in milk production occurred because the cows were split into groups by milk production level. Level of production effects followed a similar pattern to period effects. This pattern explains the decrease in both fat and protein percentage and the increase in both fat and protein yield as the level of production increased. Feed efficiency increased steadily from low to high producers while both concentrate and protein efficiency were higher for the high producing animals versus the mid and low producing animals. This is expected as higher milk yield, relative to intake, will lead to increases in efficiencies.

As production level increased the concentration of acetate and butyrate decreased while the concentration of propionate increased. This is due to the increase in concentrate consumption by the higher producing animals as increased concentrate consumption, relative to forage intake, leads to an increase in propionate concentration (Smith 1988).

Other Interactions

The decreased concentrate consumption by the high producing cows in period 1 compared to period 2 may be due to the fact that the animals were in early lactation and may not have reached peak intake (Collier 1985) while the increased concentrate consumption by the low producing cows in period 1 compared to period 2 is expected as their production level also decreased from period 1 to period 2. The interaction between period and level of production in average daily gain may have occurred because weight gain is influenced by the level of milk production as well as the stage of the lactation cycle the animal is in with decreased gain or increased weight loss occurring at early lactation and peak production (Appleman et al. 1985).

CONCLUSION

In summary, it was found that the feeding of a textured concentrate led to an increase in both milk fat percentage and yield as well as an increase in acetate production and a subsequent decrease in propionate production when compared to a pelleted concentrate. As well, the efficiency calculations show that the textured concentrate was used more efficiently for milk fat production than the pelleted concentrate. These results indicate that the feeding of a textured concentrate may lead to increased milk fat production when the animals are receiving a milk fat depressing diet such as the one fed in this trial.

TABLE 2-1. Components in the concentrate (as fed basis)

Component	Percentage
Barley	50
Corn	17
Canola	17
Distillers grain	10
Molasses	2.5
Multiphos	1.5
Limestone	1.0
Trace mineral/vitamin premix/salt	1.0

TABLE 2-2. Concentrate and cube analysis

Component	Concentrates (6 samples)	Alfalfa Cubes (8 samples)
Crude protein %	21.07	17.37
ADF	18.69	44.69
NDF	39.36	66.55
Calcium	1.02	0.96
Phosphorus	0.77	0.25

note: Both the textured and the pelleted concentrates were made from the same batch of components but the composite sample for the textured concentrate was lost, due to spoilage, prior to analysis.

TABLE 2-3. Daily feed intake (DM basis) and milk production - processing effects

Components	Pelleted	S.E.	Textured	S.E.
Alfalfa cubes kgd^{-1}	11.92	0.63	12.34	0.63
Concentrate kgd^{-1}	10.84	0.38	10.59	0.37
Milk yield kgd^{-1}	28.21	2.08	27.73	2.08
Fat %	2.35a	0.21	3.13b	0.21
Fat kg	0.69a	0.05	0.86b	0.05
Protein %	3.21	0.07	3.24	0.07
Protein kg	0.94	0.03	0.95	0.03
Lactose %	4.89	0.10	4.87	0.10
A.D.G.	0.23	0.19	0.21	0.20
Feed effic.[1]	1.33	0.056	1.29	0.056
Concentrate effic.[2]	2.71	0.095	2.75	0.095
Fat effic.[3]	0.063a*	0.006	0.085b*	0.006
Protein effic.[3]	0.086	0.003	0.088	0.003

a,b Means on the same line followed by different letter(s) differ ($P<0.05$)
* ($P<0.01$)

[1] Calculated as milk/(cube + concentrate intake).
[2] Calculated as milk/concentrate intake.
[3] Calculated as protein or fat/concentrate intake.

TABLE 2-4. Pelleted versus textured concentrate and VFA concentration (molar %)

Components	Pelleted	S.E.	Textured	S.E.
Acetate	59.69a	0.72	61.89b	0.74
Propionate	29.56a	0.96	26.79b	0.97
Butyrate	8.56	0.41	9.28	0.41
Isobutyrate	0.35	0.04	0.38	0.04
Isoval	0.37	0.05	0.32	0.05
Valeric	1.44	0.07	1.30	0.08
Acet:prop	2.16	0.14	2.48	0.14
Acet+but:prop	2.47	0.17	2.86	0.17

a,b Means on the same line followed by different letter(s) differ ($P<0.05$)

TABLE 2-5. Daily feed intake (DM basis) and milk production - period effects

Component	Period 1	S.E.	Period 2	S.E.
Alfalfa cubes kgd^{-1}	11.42	0.63	12.84	0.63
Concentrate kgd^{-1}	10.90	0.38	10.53	0.38
Milk yield kgd^{-1}	29.78a	2.08	26.16b	2.08
Fat %	2.90	0.21	2.58	0.21
Fat kg	0.90a	0.05	0.66b	0.05
Protein %	3.20	0.07	3.25	0.07
Protein kg	1.02a	0.03	0.87b	0.03
Lactose %	4.87	0.10	4.89	0.10
A.D.G.	-0.60a	0.20	1.05b	0.18
Feed effic.[1]	1.44a	0.056	1.18b	0.056
Concentrate effic.[2]	2.91a*	0.095	2.56b*	0.095
Fat effic.[3]	0.083a*	0.006	0.065b*	0.006
Protein effic.[3]	0.092a*	0.003	0.082b*	0.003

a,b Means on the same line followed by different letter(s) differ ($P<0.01$)
* ($P<0.05$)

[1] Calculated as milk/(cube + concentrate intake).
[2] Calculated as milk/concentrate intake.
[3] Calculated as protein or fat/concentrate intake.

TABLE 2-6. Daily feed intake (DM basis) and milk production - level of production effects

Component	Level 1 (LOW)	S.E.	Level 2 (MID)	S.E.	Level 3 (HIGH)	S.E.
Alfa. cubes kg	12.15	0.39	13.26	0.89	10.98	0.87
Concentrate kg	9.12a	0.24	11.82b	0.54	11.20b	0.53
Milk yield kg	19.90a	1.28	28.02b	2.92	35.99c	2.86
Fat %	3.10a	0.13	2.81ab	0.30	2.31b	0.29
Fat kg	0.65a	0.03	0.81ab	0.07	0.88b	0.07
Protein %	3.33a	0.04	3.32a	0.10	3.02b	0.09
Protein kg	0.69a	0.02	0.96b	0.05	1.18c	0.04
Lactose %	4.80	0.06	5.00	0.14	4.84	0.14
A.D.G.	0.15	0.12	0.16	0.26	0.35	0.28
Feed effic.[1]	0.98a	0.034	1.24b	0.078	1.70c	0.077
Conc. effic.[2]	2.29a	0.059	2.50a	0.134	3.40b	0.132
Fat effic.[3]	0.071	0.003	0.070	0.008	0.080	0.008
Protein effic.[3]	0.076a	0.002	0.082a	0.004	0.103b	0.004

a-c Means on the same line followed by different letter(s) differ ($P<0.05$)

[1] Calculated as milk/(cube + concentrate intake).
[2] Calculated as milk/concentrate intake.
[3] Calculated as protein or fat/concentrate intake.

TABLE 2-7. Level of production and VFA concentration (molar %)

Component	Level 1 (LOW)	S.E.	Level 2 (MID)	S.E.	Level 3 (HIGH)	S.E.
Acetate	65.92a	0.64	59.11b	1.14	57.36b	0.99
Propionate	21.25a	0.84	30.62b	1.50	32.66b	1.30
Butyrate	10.69a	0.36	8.10b	0.64	7.97b	0.55
Isobut	0.49a	0.04	0.29b	0.06	0.32b	0.05
Isoval	0.39	0.05	0.26	0.08	0.38	0.07
Valeric	1.24	0.07	1.59	0.12	1.29	0.10
Acet:prop	3.20a	0.12	1.99b	0.22	1.77b	0.19
Acet+but:prop	3.73a	0.15	2.26b	0.27	2.01b	0.23

a,b Means on the same line followed by different letter(s) differ ($P<0.05$)

CHAPTER THREE

TRIAL TWO

EFFECT OF TEXTURED AND PELLETED CONCENTRATES FED WITH SILAGE ON INTAKE AND MILK COMPONENT PRODUCTION

INTRODUCTION

Milk production is influenced by a variety of factors including genetics, environment, management, physiological state, hormonal balance, diet and feeding program (Oldham 1984; Coppock 1985). The influence of feeding systems is the easiest to manipulate and can have the largest impact on milk composition, particularly the fat and protein components (Thomas and Chamberlain 1988). With the Canadian Dairy Industry considering the implementation of a multiple component pricing system, dairy farmers will need to be more aware of relatively small changes in feeding systems and their effects on milk composition.

One such important factor to consider is the effect of processing of concentrates on milk composition and yield, especially in British Columbia, as there has been a move towards the feeding of textured concentrates. Many studies have been done looking at the effects of processing of cereal grains (Hale and Theurer 1972; Hale 1973; Hutton and Armstrong 1976; Nordin and Campling 1976; Orskov 1981; Buckley and Devlin 1983, Kempton and Hiscox 1983; Grimson et al. 1987; Gaylean and Malcolm 1991) and the general conclusion is that some form of processing is beneficial for most cereal grains, although the type of processing and the cereal grain involved will affect the results. In trial one the effects of steam flaking versus pelleting on a barley-corn concentrate fed along with alfalfa cubes were studied and it was found that the feeding of textured feed led to an increase in milk fat production. However, in B.C., the majority of feeding systems have silage and high quality pasture as the main forage component of the ration. These succulent forages in combination with minor changes in components, or form of the concentrate mixture, can lead to milk fat depression (Sutton 1988). Thus, this study was conducted to determine the influence of a textured versus a pelleted dairy concentrate on milk yield, milk composition and intake when fed in conjunction with a grass-corn silage mixture.

MATERIALS AND METHODS

Diet

A barley, corn and canola meal based dairy concentrate was formulated at the Agassiz Agriculture Canada Research Station feedmill. The concentrate was processed according to two different methods: pelleted and textured. The pelleted concentrate was formed by first grinding all the ingredients through a hammermill and then pressing them into a cylindrical pellet through the addition of heat at approximately 70^{0}C. In the textured concentrate the barley and corn were steam rolled at approximately 85^{0}C while the remainder of the ingredients were ground and pelleted. Both diets were identical in composition (Table 3-1 and 3-2).

Animals

The concentrates were fed to a group of 14 Holstein cows along with a 50/50 mix of corn and grass silage which was fed ad lib. The concentrates were fed according to production with 1 kg of concentrate given for each 2.5 kg of milk production. Milk production was recorded daily and the concentrate allotment for each animal was adjusted weekly. The lowest level of concentrate given was 9.5 kg even if the milk production of an animal fell below 23.75 kg production. The animals were at various stages in their lactations but were not divided into groups according to production level as trial one indicated that responses were similar at different production levels.

Treatments

The experiment was run in a change-over design (Gill and Magee 1976) with two periods in which all animals received both diets. The animals were split randomly into the two treatment groups with level of production being taken into account. The first period was 28 days in length while the second period was decreased to 20 days in length due to a shortage of textured feed.

Data Collection

Silage and concentrate were fed twice daily. Calan doors were used to accurately determine individual intake. Milk production was also recorded daily. The animals were weighed on the first three days of each period and again on the last two days of period 2 and an average was taken of each sampling period. Milk was sampled for composite analysis. Jugular blood samples collected by intravenous procedure and rumen samples collected by stomach tube were taken on the 8th and 22nd days of period 1 and on the 11th and 19th days of period 2. The milk samples were collected over a 2 day period and combined in proportion to the volume of milk produced at each milking. Silage was sampled daily and dryed to determine DM% which was then averaged on a weekly basis. From these daily samples weekly composite samples were formed. Concentrates were sampled weekly and DM% was determined for each concentrate. The lab analysis was conducted from the weekly composite samples for both silage and concentrate which were ground to pass through a 2mm screen and then an overall average was taken for each feedstuff.

Analysis

The milk samples were sent to the B.C. Ministry of Agriculture and Food Marketing Branch and analyzed for fat, protein and lactose using an Infra Red Milk Analysis system (Multispec Ltd., Brampton, Ont.) and somatic cell count (SCC) were also recorded. The composite samples of the silage, pelleted and textured concentrate were analyzed for protein using the wet ash method of Parkinson and Allen (1975) followed by the Technicon Auto analyzer while ADF and NDF were analyzed using both the acid detergent fiber method and neutral detergent fiber method of Waldern (1971) (Table

3-3). Blood samples were analyzed for packed cell volume (PCV) by hematocrit, blood urea nitrogen (BUN) and glucose (Kodak Ektachem DT60 colorimetric analyzer, Inland Laboratories, Kamloops, B.C.). Rumen samples were analyzed for pH at the Agriculture Canada lab at Agassiz and analyzed for volatile fatty acid (VFA) distribution at the Agriculture Canada lab at Kamloops. Volatile fatty acids were analyzed by HPLC, using the extraction method outlined in Guerrant et al. (1982). HPLC apparatus consisted of a Spectra-Physics with a SP 8450 uv/vis detector, SP 8800 ternary HPLC pump and a SP 4290 integrator (Mississauga, ON L5S 1W7), equipped with an anion exchange column, 220 x 4.6 mm (length x diameter), packed with polypore H 10 um (Brownlee Laboratories, cat. no. BRP4615, Santa Clara, CA 95050). The machine was run at room temperature with pressure at 700 to 800 PSI. An isocratic mobile phase was used employing 0.01N H2SO4. Volatile fatty acids were detected at 210 nm. The VFA concentrations were determined from a standard curve developed by running standard VFA solutions ranging in concentration. The standards consisted of lactic (360 to 1,440 ugml-1), acetic (1,200 to 4,800 ugml-1), propionic (740 to 2,960 ugml-1), isobutyric (180 to 720 ugml-1), butyric (520 to 2,080 ugml-1), 2 methylbutyric (200 to 800 ugml-1), isovaleric (200 to 800 ugml-1) and valeric (400 to 1,600 ugml-1) acids. The values for butyric acid represent isobutyric, butyric and 2 methylbutyric combined.

For statistical analysis each period was broken into subperiods with subperiod 1 period 1 being 14 days in length, subperiod 2 period 1 also 14 days, subperiod 1 period 2 being 13 days and subperiod 2 period 2 being 5 days. Data were analyzed using the GLM analysis of variance procedures of SAS (S.A.S. 1985). Cow, period and treatment affects were studied.

RESULTS

Concentrate Processing Effects

Milk fat percentage was significantly ($P<0.01$) higher for textured feed but fat calculated as yield/day showed no significant difference between the two concentrates. Both silage intake ($P<0.05$) and concentrate intake ($P<0.01$) were significantly higher with textured feed. Milk production however, was significantly ($P<0.01$) lower for animals fed the textured concentrate. Protein on yield/day basis was significantly ($P<0.01$) higher for pelleted feed while both rumen pH and packed cell volume (PCV) were significantly ($P<0.01$) lower with pelleted feed (Table 3-4). Pelleted concentrate also had significantly ($P<0.01$) higher feed, concentrate, fat and protein efficiencies than the textured concentrate.

Period Effects

Milk production was significantly higher ($P<0.01$) in period 1 while both protein % and fat % were significantly ($P<0.01$) lower in period 1. When fat and protein yield/day were calculated, no significant differences were found between periods. A significant difference ($P<0.05$) was found in silage consumption with period 2 intake being slightly higher than that of period 1. Feed and concentrate efficiencies were significantly ($P<0.01$ and $P<0.05$ respectively) higher in period 1. Packed cell volume (PCV), glucose and rumen pH were all significantly ($P<0.01$) higher in period 1 (Table 3-5). There were no significant differences in VFA concentrations between periods or concentrates (Table 3-6).

Other Interactions

Significant subperiod(period) interactions occurred with concentrate intake ($P<0.01$), milk production ($P<0.01$), fat % ($P<0.05$), pH ($P<0.05$), SCC ($P<0.05$), PCV ($P<0.05$), BUN ($P<0.01$) and glucose ($P<0.01$). Both concentrate intake and glucose were higher in subperiod 1 than subperiod 2 of each period while blood urea nitrogen (BUN) was higher in subperiod 2 than in subperiod 1 of each period. Milk production, rumen pH and PCV steadily decreased from subperiod 1 period 1 to subperiod 2 period 2 while the fat % steadily increased. Somatic cell count (SCC) decreased from subperiod 1 period 1 to subperiod 1 period 2 and than increased again in subperiod 2 period 2.

In terms of feed efficiency, there was no significant ($P<0.05$) difference between periods but subperiod 1 period 2 was significantly lower than both subperiod 1 and 2 in period 1. Concentrate efficiency was not significantly

($P<0.05$) different between subperiods in period 1 but in period 2 subperiod 1 was significantly lower than subperiod 2. Both fat and protein efficiency increased from subperiod 1 to subperiod 2 in each period.

DISCUSSION

Concentrate Processing Effects

Animals fed the textured ration showed a higher percentage of milk fat (approximately 0.33 percentage units) than those on pelleted diets. This may be due to increased rumen stimulation caused by the husk remaining intact in the textured concentrate (Nordin and Campling 1976). As well, both the ADF and NDF values were higher for the textured concentrate than that of the pelleted. This agrees with the results found by Malcolm and Kiesling (1993) that steam flaked grains had a consistent increase in ADF compared to ground grains. These workers hypothesized that the elevated ADF content in steam flaked grains may be due to formation of artifact lignin when processed at temperatures above 65^{o}C. Also, variation in fiber content may indicate separation of the grain kernel into components, particularly flakes containing greater quantities of pericarp (Malcolm and Kiesling 1993). However, there was no significant increase in the concentration of acetic acid, one of the main precursors of milk fat (Sutton 1988), although the results indicate a slight, but not significant, increase in acetic acid concentration in the textured feed. Another cause of the increase in milk fat percentage may be due to the decrease in milk production for the animals fed textured concentrate as fat on a yield basis showed no significant difference between concentrates.

The daily protein yield was 0.07 kg higher for animals fed the pelleted feed. Sutton (1980) and Thomas and Chamberlain (1988) found higher milk protein content with high starch diets and attributed it to an increase in the availability of propionic acid. However, in this case both feeds are high in available starch and there are no significant differences in volatile fatty acid concentration. The higher amounts of heat and moisture used in processing the textured concentrate may have caused the protein to denature or the formation of carbohydrate and protein complexes (Gaylean and Malcolm 1991) thus limiting the amount of protein available from the feed.

Silage and concentrate dry matter intake were both higher for animals receiving the textured diet (0.48 kg and 1.04 kg higher respectively). The increase in textured concentrate consumption may be due to the textured feed being more palatable than the pelleted feed. However, this is not likely as the only feed refusals and weigh backs occurred when the textured concentrate was fed. The high moisture content of the pelleted grain may also be responsible for the difference in intake as it was calculated on a dry matter basis. As well, milk production was 1.95 kg lower for animals fed the textured concentrate even though intake was higher. This resulted in the pelleted feed having higher feed, concentrate, fat and protein efficiencies than the textured feed. This indicates that the pelleted concentrate was being used more efficiently in both milk and milk component production. Also, with the pelleted feed animals may not have been able to reach maximum intake due to the high moisture content of the concentrate so efficiencies may actually be even higher than those calculated.

The rumen pH was .21 units higher for animals fed the textured feed as compared to the pelleted. The rumen pH may vary as the result of several factors such as, composition and physical structure of the feed, mastication, buffering capacity and rumen micro-organisms present in each individual animal (Orskov 1990). The increase in pH with the textured feed may be due to the fact that feeds which include the fibrous husks result in a greater extent of mastication (Nordin and Campling 1976) and this increase in mastication causes an increase in salivation and bicarbonate secreted in the saliva is the most important buffering agent in the ruminant system thus resulting in pH remaining at a higher level (Orskov 1990).

Hematocrit value or packed cell volume (PCV) is the percentage by volume of whole blood that is constituted by red blood cells and the normal range in cattle is around 40% (Frandson 1986). The PCV was found to be 1.16 percentage units lower for pelleted feed. This difference may be due to many factors as red blood cell volume is affected by age, sex, exercise, nutritional status, lactation, pregnancy, ovulation, excitement, blood volume, stage of estrous cycle, breed, time of day, environmental temperature, altitude and other climatic factors (Swenson 1990).

Period Effects

Fat was found to be 0.31 percentage units higher in period 2 while protein was 0.21 percentage units higher. This increase in both fat and protein percentage from period 1 to period 2 is due to the fact that as an animal progresses in her lactation cycle both fat and protein content gradually increase while milk production and lactose content tend to decrease (Maynard et al. 1979; Collier 1985).

Silage intake was found to be 0.52 kg higher in period 2 than in period 1. This may be due to a variety of factors such as colder temperatures during period 2 or a change in the palatability or quality of the corn:grass silage since it was mixed on a daily basis and as the trial progressed the silage came from different sections of the silo bag. Milk production was 1.52 kg higher in period 1 compared to that of period 2. This change is to be expected as it is a direct comparison of each individual cow's production, and as period 2 occurred later in the lactation cycle the milk production of each animal would have decreased (Appleman et al. 1985). Both feed and concentrate efficiencies were higher in period 1 than in period 2 which is to be expected as milk yield is higher in period 1 and efficiency is calculated based on yield relative to consumption.

The rumen pH was 0.2 units higher in period 1, however, pH remained in the optimal range of 6.5 to 6.8 for rumen microbes (Grant and Mertens 1992). As mentioned previously a variety of factors may affect pH and a small shift such as this is not of great biological importance. The hematocrit values for period 1 and 2 were both slightly below the normal range in cattle of 40% (34.02 and 32.86% respectively) with period 1 being significantly higher (Frandson 1986). Again this difference may be due to a variety of factors. The blood glucose was 4.39 $mgdL^{-1}$ higher in period 1 than in period 2. This increase in blood glucose is likely due to gluconeogenesis as the animals were at peak lactation in period 1 and the demand for glucose is high at this point (Bergman 1977). However, blood glucose levels were within the normal range stated for cattle of 40 to 80 $mgdL^{-1}$ for both periods (Collier 1985). There is also the assumption that large amounts of post-ruminal starch contribute appreciably to the glucose supply although not all studies have confirmed this finding (Sutton 1988) and as this difference occurred between periods it is not likely that this was a factor.

CONCLUSION

The feeding of a textured concentrate versus a pelleted concentrate again led to an increase in milk fat percent. However, in this trial there was no subsequent increase in milk fat yield or acetate concentration. Therefore the increase in milk fat percent is likely due to the decrease in milk yield that occurred when the textured concentrate was fed. As well, the pelleted concentrate had higher feed, concentrate, fat and protein efficiencies showing that it was used more effectively for both milk and component production. These results indicate that textured feed may only increase milk fat production when feed to animals receiving a milk fat depressing diet such as that fed in trial one.

TABLE 3-1. Composition of the concentrate (%)

Component	Pelleted	Textured
Barley	44.5 [1,3]	44.5 [2]
Corn	20.0 [1,3]	20.0 [2]
Canola	17.0 [3]	17.0 [3]
Distillers grain	10.0 [3]	10.0 [3]
Molasses	5.0 [3]	5.0 [3]
Multiphos	1.5 [3]	1.5 [3]
Limestone	1.0 [3]	1.0 [3]
Cobalt-iodized salt	0.5 [3]	0.5 [3]
Vitamin trace mineral premix	0.5 [3]	0.5 [3]

[1] Dry ground in hammermill.
[2] Steam rolled.
[3] Pelleted.

TABLE 3-2. Composition of vitamin trace mineral pre-mix (g/100kg)

Component	Amount
Zinc sulphate 36% Zn	1400
Manganese sulphate 27% Mn	740
Copper sulphate 25% Cu	500
Sodium selenite 40% Se	200
Vitamin A 500,000 IU/g	66
Vitamin D3 500,000 IU/g	6.6
Vitamin E 50,000 IU/g	50

TABLE 3-3. Average dry matter%, nitrogen content, ADF and NDF of the silage and concentrates.

Component	Textured	S.E.	Pelleted	S.E.	Silage	S.E.
Dry matter%	81.70a	2.82	73.50a	2.82	26.80b	2.82
Crude protein	20.13a	0.34	19.45a	0.34	12.02b	0.34
ADF	12.49a	0.38	10.20b	0.38	35.02c	0.36
NDF	28.19a	1.26	23.88b	1.18	58.49c	1.18

a-c Means on the same line followed by different letter(s) differ ($P<0.05$)

TABLE 3-4. Daily feed intake (DM basis) and milk production - processing effects

Components	Textured	Pelleted	S.E.	P<
Silage kgd^{-1}	12.69a	12.21b	0.1566	0.05
Concentrate kgd^{-1}	9.62a	8.58b	0.1136	0.01
Milk yield kgd^{-1}	27.38a	29.33b	0.1564	0.01
Fat %	4.05a	3.72b	0.0559	0.01
Fat kg	1.11	1.08	0.0203	
Protein %	3.20	3.21	0.0347	
Protein kg	0.87a	0.94b	0.0098	0.01
Lactose %	4.60	4.67	0.0331	
Rumen pH	6.79a	6.58b	0.0434	0.01
Hematocrit %	34.02a	32.86b	0.2086	0.01
Glucose $mgdL^{-1}$	60.39	62.07	0.7500	
SCC	144535	137678	23280	
BUN $mgdL^{-1}$	9.96	9.71	0.2083	
ADG kgd^{-1}	-0.20	-0.06	0.1122	
Feed effic.[1]	1.23a	1.41b	0.0167	0.01
Conc. effic.[2]	2.84a	3.43b	0.0501	0.01
Fat effic.[3]	0.115a	0.128b	0.0030	0.01
Protein effic.[3]	0.091a	0.110b	0.0018	0.01

a,b Means on the same line followed by different letter(s) differ

SCC - somatic cell count
BUN - blood urea nitrogen

[1] Calculated as milk/(silage + concentrate intake).
[2] Calculated as milk/concentrate intake.
[3] Calculated as protein or fat/concentrate intake.

TABLE 3-5. Daily feed intake (DM basis) and milk production - period effects.

Component	Period 1	Period 2	S.E.	P<
Silage kgd^{-1}	12.19a	12.71b	0.1566	0.05
Concentrate kgd^{-1}	9.09	9.12	0.1136	
Milk yield kgd^{-1}	29.11a	27.59b	0.1564	0.01
Fat %	3.73a	4.04b	0.5590	0.01
Fat kg	1.08	1.12	0.0203	
Protein %	3.10a	3.31b	0.0347	0.01
Protein kg	0.90	0.91	0.0098	
Lactose %	4.65	4.62	0.0331	
Rumen pH	6.78a	6.58b	0.0434	0.01
Hematocrit %	34.02a	32.86b	0.2086	0.01
Glucose $mgdL^{-1}$	63.43a	59.04b	0.7500	0.01
SCC	118571	163642	23280	
BUN $mgdL^{-1}$	9.64	10.04	0.2083	
ADG kgd^{-1}	-0.14	-0.12	0.1122	
Feed effic.[1]	1.37a	1.27b	0.0166	0.01
Conc. effic.[2]	3.21a	3.06b	0.0501	0.05
Fat effic.[3]	0.119	0.124	0.0029	
Protein effic.[3]	0.100	0.101	0.0018	

a,b Means on the same line followed by different letter(s) differ

SCC - somatic cell count
BUN - blood urea nitrogen

[1] Calculated as milk/(silage + concentrate intake).
[2] Calculated as milk/concentrate intake.
[3] Calculated as protein or fat/concentrate intake.

TABLE 3-6. Volatile fatty acid concentration (um/ml) - concentrate and period effects

	Acetic	S.E.	Propionic	S.E.	Butyric	S.E.
Period 1	96.55	4.92	27.18	2.53	2.79	0.26
Period 2	101.81	4.92	21.48	2.53	2.43	0.26
Textured	99.33	4.92	22.06	2.53	2.71	0.26
Pelleted	99.03	4.92	26.60	2.53	2.51	0.26

CHAPTER FOUR

TRIAL THREE

COMPARISON OF THE EFFECT OF TEXTURED AND PELLETED CONCENTRATE ON RUMINAL DEGRADATION CHARACTERISTICS

INTRODUCTION

The influence of processing on the digestibility of cereal grains has been considered in many studies (Buckley and Devlin 1983; Kempton and Hiscox 1983; Mandell et al. 1988; Focant et al. 1990a; Focant et al. 1990b) using both in vitro and in vivo techniques. It has been demonstrated that appropriate heat treatment applied during grain processing can decrease ruminal degradation of protein (Hale 1973) and can lead to increased weight gain, nitrogen retention, feed efficiency or milk yields (Stern 1981; Forster et al. 1983). Of particular interest is the effect of steam flaking on cereal grains. Steam flaking has been shown to decrease nitrogen degradability (Focant et al. 1990a), gelatinize the starch of cereal seeds (Papasolomontos and Wilkinson 1976) thereby improving the digestibility of the starch (Theurer 1986), alter ruminal digestion (Owens and Bergen 1983), and to increase the duodenal amino acid supply (Focant et al. 1990b). However, most of these studies look at individual cereal grains and not mixed concentrates. Malestein and Van't Klooster (1986) found that fermentation rates of concentrate mixtures are sometimes higher than expected from the experiments with single concentrates, assuming additive effects. This study was conducted to examine the effects of concentrate processing (textured versus pelleted) of a mixed barley and corn concentrate on the site and extent of nutrient digestion in dairy cattle and to compare the dry matter and nitrogen degradability as well as the digestion kinetics of these two concentrates and a corn:grass silage mixture.

MATERIALS AND METHODS

Two, nonlactating, Holstein cows fitted with rumen cannulae, and one with a duodenal cannula, were fed a diet consisting of 5.5 kg of an alfalfa (60%) and grass hay (40%) mixture and 3.0 kg of 16% protein dairy concentrate. The feed, in four equal portions, was fed every six hours in order to reduce rumen fluctuations. Pelleted and textured concentrate (Table 3-1 and 3-3) and a 50:50 corn:grass silage were the feeds studied. All feeds were ground through a 1 mm screen prior to incubation. Nylon bags (5 x 10 cm), prepared in quadruplicate (two replicates per cow per time), were incubated in reverse order for 96, 72, 48, 24, 12, 8, 4, 2 and 0 hours for the silage and 72, 48, 24, 12, 8, 4, 2 and 0 hours for the concentrates. Sample quantities decreased with decreasing time of incubation, ranging from 5.0 g for 96 h to 3.0 g for 0 h for the silage and 4.0 g for 72 h to 2.0 g for 0 h for the concentrates. Each feed was incubated in two cows and a maximum of three feeds were incubated in one cow per run. Following ruminal incubations, all bags were hand washed until the rinse water remained clear. Samples were dried in a forced air oven at 55 oC until constant weight was achieved. Replicates within cows were pooled and ground through a 0.5 mm screen prior to all laboratory analyses.

Intestinal disappearance was determined using the mobile nylon bag technique (de Boer et al. 1987). Duodenal bags (3.5 x 5 cm) were prepared using an Audion Electro Sealmaster #230. Bags were filled with 0.5 g of material for the silage and 1.0 g for the concentrates and incubated in quadruplicate in the rumen for 12 h. Following rumen incubation the bags were rinsed thoroughly and were either immediately placed in the duodenum through a T-shaped cannula or stored at 4^{o}C until time of insertion. No more than one bag was inserted every 30 minutes. Duodenal bags were collected in the feces and subjected to the same washing procedure described previously. Samples were pooled prior to being analyzed for DM and nitrogen.

Effective Degradability

The percent dry matter digested and percent protein digested at each incubation time was calculated and the rate of degradation was estimated using non-linear regression (Statistical Analysis Systems Institute (S.A.S.) 1985). The equation (Dhanoa 1988)

$$p = a + b \left[1 - e^{-c(t-Lt)} \right]$$

was used where *p* is the proportion of dry matter digested at time *t*, *a* is the proportion of readily soluble material, or that portion of the protein or dry matter that disappeared within the first 0.5 h of incubation, and b is the potentially degradable material which was degraded at rate c (h-1), after a lag time (Lt) in the initiation of digestion.

The effective degradability *P* was calculated using the equation of Orskov and McDonald (1979) and revised by McDonald (1981)

$$P = a + ((bc)/(c + k)) * e^{(-Lt)(k)}$$

where *a*, *b* and *c* are as defined previously, and *k* is the rate of passage of feed through the rumen. *P* was determined with *k* defined as 0.035 for the concentrates and 0.05 for the silage (Fox et al. 1988).

Statistical Analysis

Analysis of variance (S.A.S. 1985) were carried out for the readily soluble fraction, the degradable fraction, rate of degradation, lag time and effective degradability and Student-Newman-Keuls test was used to compare the means (S.A.S. 1985) for both dry matter degradability and protein degradability of the duodenal samples.

RESULTS

Degradation Characteristics of Dry Matter

The readily soluble fraction was higher ($P<0.01$) for the pelleted versus the textured concentrate while no other significant differences occurred between the two concentrates (Table 4-1). Dry matter disappearance (DMD) from the rumen, intestine and total tract did not differ between the pelleted and textured concentrates (Table 4-3).

Degradation Characteristics of Protein

In terms of protein degradability, the pelleted concentrate had a higher readily soluble fraction ($P<0.01$) and effective degradability ($P<0.05$) than the textured concentrate (Table 4-2). The crude protein disappearance (CPD) from the rumen, intestine and total tract did not differ significantly between the two concentrates (Table 4-3).

DISCUSSION

Degradation Characteristics of Dry Matter

In general, gelatinization caused by heat and moisture in steam flaked grains leads to a greater extent of starch digestion in the rumen (Galyean and Malcolm 1991). However, in this trial the readily soluble fraction of the dry matter was higher for the pelleted versus the textured concentrate. Similarly, Kempton and Hiscox (1983) found that pelleting increased the soluble dry matter degradation over that of extruded barley with no resulting difference in overall DMD. A possibility for this reduction in the digestibility of the readily available or soluble fraction of the textured feed is that the presence of such high moisture and the addition of heat may have precipitated undesirable reactions rendering the starch less available for rapid fermentation (Seib 1971) or led to retrogradation, or reassociation of the starch granules, slightly reducing the digestibility of the flaked grains (Rooney and Pflugfelder 1986). Also, certain types of processing may lead to formation of undigestible starch-protein complexes (Thorne et al. 1983) although this is not likely in this case as there were no significant differences in effective degradabilities or total tract DMD.

The values of ruminal DMD for the textured and pelleted concentrates were similar to that found for steam flaked corn at 66.5% (Zinn 1990), although both were higher than the value of 60.4% for steam flaked barley (Zinn 1993). The total tract DMD values for both concentrates were similar to those found for steam flaked corn at 83.4% (Zinn 1990) and steam flaked barley at 82.3% (Zinn 1993).

The results of the DMD of the silage were in between those reported by Mir et al. (1991) for corn and alfalfa silage (readily soluble 22 and 38%, insoluble degradable 66 and 26%, rate of degradation 0.02 and 0.33, lag time 3.01 and 3.21h and effective degradability 49 and 61%), although the lag time was quite high at 6.54h. Mir et al. (1992) found that the soluble fraction was large for silages with a low DM content (below 30%), as was the corn-grass silage used in this trial (Table 3-3), suggesting a greater extent of degradation during the ensiling process. As well, silages with lower DM content tend to have greater effective degradabilities due to the higher proportion of solubles (Makoni et al. 1991; Mir et al. 1992) which may be caused by greater fermentation in the silo. The break down of sites of digestion shows that the majority of DMD for the silage occurred in the rumen. This is also confirmed by the fact that total tract DMD for the silage was slightly higher than it's effective degradability, indicating not much further digestion of the silage took place after it passed out of the rumen.

Degradation Characteristics of Protein

Both the readily soluble fraction and the effective crude protein degradability were higher for the pelleted concentrate than the textured concentrate. This agrees with the findings of Papasolomontos and Wilkinson (1976) that steam flaking decreases the nitrogen solubility in barley and maize and those of Focant et al. (1990b) that steam flaking decreases nitrogen solubility resulting in an increase in the supply of amino acids to the intestine. Therefore, the lower readily soluble fraction and effective CPD for the textured concentrate may be due to the fact that steam flaking uses higher temperatures than pelleting and may better protect the protein fraction from degradation as heat treatment can decrease ruminal degradation of protein (Hale 1973).

The value for steam flaked corn at 63.5% (Zinn 1990) was similar to that found in the textured concentrate while the pelleted concentrate had a slightly higher rumen CPD%. Total tract CPD of both the textured and pelleted concentrates were much higher than that found by Zinn (1990 and 1993) in either corn or barley.

The readily soluble fraction of the crude protein degradability was highest for the silage which is to be expected as ensiling can lead to extensive proteolysis and an associated increase in nitrogen solubility (Thomas and Beever 1980). The readily soluble fraction found for the corn:grass silage used in this trial was 63.82% which is similar to that of the 66% found for corn silage by the AFRC (1993). Although some lag time is expected for silages, the value of 6.88 hours found in this trial is quite a high value for protein degradability. The silage effective CPD was found to be higher than that of early cut corn silage but similar to that of corn sunflower silage reported by Mir et al. (1992). Overall tract CPD was over 80%, indicating that it was well utilized.

CONCLUSION

In summary, steam flaking led to a decrease in both DM and CP readily soluble fraction and to a decrease in CP effective degradability. However, there was no significant difference between the two concentrates in terms of DMD or CPD, indicating that overall tract utilization was similar for the two feeds.

TABLE 4-1. Dry matter degradability

Component	Readily soluble fraction *a*	Insoluble degradable fraction *b*	Rates of degradation (h-1) *c*	Lag time (h) *Lt*	Effective degradability
Textured	49.57 a*	38.16 b	0.04695 a	0.0 b*	71.43 a
Pelleted	54.83 b*	33.61 b	0.07509 a	0.0 b*	77.31 a
Silage	36.83 c*	57.59 a	0.03209 a	6.54 a*	50.42 b
S.E.	1.50×10^{-1}	3.31	1.76×10^{-2}	1.33×10^{-1}	3.42

a-c Means in the same column followed by different letter(s) differ ($P<0.05$)
*($P<0.01$)

note: Flow rate used for effective degradability was 3.5% for concentrates and 5% for silage.

TABLE 4-2. Crude protein degradability

Component	Readily soluble fraction *a*	Insoluble degradable fraction *b*	Rates of degradation (h-1) *c*	Lag time (h) *Lt*	Effective degradability
Textured	43.43 a*	46.18 a	0.05691 a	0.0 b*	71.86 b
Pelleted	52.28 b*	40.11 a	0.05868 a	0.0 b*	77.16 a
Silage	63.82 c*	32.57 b	0.01806 a	6.88 a*	69.89 b
S.E.	1.92×10^{-1}	1.38	8.03×10^{-3}	1.28×10^{-1}	1.16

a-c Means in the same column followed by different letter(s) differ ($P<0.05$)
* ($P<0.01$)

note: Flow rate used for effective degradability was 3.5% for concentrates and 5% for silage.

TABLE 4-3. Rumen, intestine and total tract DMD and CPD of the silage and concentrates

	Textured	S.E.	Pelleted	S.E.	Silage	S.E.
DMD%						
Rumen[1]	67.33a	1.75	72.36a	2.02	42.04b	1.75
Intestine[2]	18.91	2.22	16.07	1.81	14.16	1.81
Total tract[3]	86.12a	2.24	88.43a	1.83	57.13b	1.83
CPD%						
Rumen	64.23	1.78	70.40	2.06	67.33	2.06
Intestine	31.14a	2.45	25.67a	2.00	15.43b	2.00
Total tract	95.25a	0.89	96.07a	0.73	82.75b	0.73

a,b Means in the same row followed by different letter(s) differ ($P<0.05$)

[1] Percent of total DM or/ protein disappearing in the rumen, calculated as average of DMD or/ CPD at 12 hour incubation time.
[2] Percent of total DM or/ protein disappearing in the intestine, calculated as (average of duodenal DMD or/ CPD samples - rumen DMD or/ CPD).
[3] Average of duodenal DMD or/CPD samples disappearance in the total tract.

CHAPTER FIVE

GENERAL DISCUSSION

Trial 1 and 2 focused on the effect of textured and pelleted concentrates on milk composition and related changes in rumen volatile fatty acid (VFA) concentrations. In both trials it was found that the animals fed the textured ration had a higher percentage of milk fat (0.78 and 0.33 milk percentage units respectively). In trial 1 this increase in milk fat production was accompanied by changes in the rumen VFA concentrations. Usually, when high heat and moisture are used in processing, an increase in ruminal starch digestion will occur leading to an increase in propionate production (Murphy et al. 1982; Nocek and Tamminga 1991). However, in trial 1 the rumen acetate concentration increased while the propionate concentration decreased, a result which may be due to the formation of indigestible starch-protein complexes (Thorne et al. 1983) or to the fact that with a textured concentrate the husk remains intact and may lead to more rumen stimulation (Nordin and Campling 1976). In trial 2, no significant differences were found in VFA concentrations between the two concentrates. Thus, the increase in milk fat percentage may be due to the intact husk causing rumen stimulation or to the fact that milk production decreased in the animals fed the textured concentrate, since fat on a yield/day basis showed no significant difference between concentrates. In trial 1 no other differences in milk composition occurred between the textured and pelleted concentrates, although in trial 2, protein on a yield/day basis was lower for animals fed the textured concentrate. This increase in protein yield for animals fed the pelleted concentrate could be due to the decreased nitrogen solubility in the textured feed caused by denaturation of the protein or formation of carbohydrate and protein complexes caused by the higher heat and moisture used in processing (Papasolomontos and Wilkinson 1976; Focant et al. 1990b; Gaylean and Malcolm 1991). As well, the increased availability of the protein in the pelleted feed compared to the textured may have lead to increased microbial protein production which may have also contributed to the increase in milk protein found in animals fed the pelleted concentrate (Nocek and Tamminga 1991).

Trial 1 and 2 also studied the intake characteristics of the pelleted and textured concentrates with trial 1 taking into account animals at different levels of production. It was found that level of production, although affecting the amount of concentrate consumed, did not result in any significant differences between the two concentrates. In trial 2 both silage and concentrate intake were significantly higher for animals fed the textured feed. Increased palatability may have lead to the increase in consumption of the textured concentrate. However, the difference is more likely caused by the high moisture content of the pelleted concentrate. Also, the efficiency calculations show that the pelleted feed was used more efficiently in regards to feed, concentrate, fat and protein.

In trial 1, the forage source was alfalfa cubes while in trial 2 a corn:grass silage was fed. As discussed earlier, both trials saw an increase in milk fat percentage, although it was higher in trial 1. This increase in trial 1 may be related to the fact that the animals were receiving a milk fat depressing diet and the extra roughage characteristics and increased rumen stimulation caused by the textured feed under these circumstances may have been enough to increase the milk fat percent and yield. In trial 2 the diet fed was not milk fat depressing since concentrate intake did not reach high enough levels due to the high moisture contents of both the textured and pelleted concentrates. This may account for the same results not being obtained in relation to milk fat between the two trials. As discussed previously, there was an increase in milk fat percent in trial 2 but, this is probably due to the subsequent decrease in milk production that occurred when the textured concentrate was fed. However, the extent to which the forage sources played a role in affecting these changes in milk composition between the two trials is hard to ascertain as there are so many other factors involved. Also, the two trials were not identical in procedure and cannot be compared statistically.

The ruminal degradation characteristics of the pelleted and textured concentrates used in trial 2 were compared in trial 3. This study found that the pelleted feed had a higher readily soluble dry matter and protein fraction, and a higher effective degradability in terms of protein than the textured feed. These results are possibly due to the higher level of heat and moisture involved in steam flaking as high heat and moisture may precipitate undesirable reactions rendering the starch less available for rapid fermentation (Seib 1971) and may decrease the nitrogen solubility of a feedstuff (Papasolomontos and Wilkinson 1976; Focant et al. 1990b). However, there were no significant differences between the two concentrates with regard to total tract dry matter and crude protein disappearance, indicating that overall both concentrates were digested to the same extent.

In order to compare the effects of the two concentrates in terms of pricing formulas, the results from trial 1 and 2 were put into the equations for the various pricing formulas listed by Emmons (1990a). In both trial 1 and 2 the textured concentrate resulted in higher values than the pelleted concentrate when comparing the formulas of fat plus constant, fat plus protein and fat plus protein plus lactose and minerals. In trial 2, the smallest differences occurred when more than one component was used in the calculations. However, these equations do not take into account milk yield since the study was not looking at the returns to producers but at how milk of different compositions may affect cost at the plant level. As well, Emmons et al. (1990a) found that changes in relative costs were affected not only by milk composition and pricing formulas, but also by the product being produced. The fat plus constant formula was the best for fluid milk, the fat plus protein plus lactose and minerals formula was the best for butter and the fat plus protein formula was the best for cheese. Therefore, the concentrate that will be the most beneficial for farmers to feed will depend on the MCP formula used and the main product of production.

CHAPTER SIX

CONCLUSION

The focus of the three dairy feeding trials was to look at the effect of concentrate processing on feed utilization and milk composition. Trial 1 and 2 looked at the effect of feeding textured and pelleted concentrates on milk composition and feed intake. Trial 3 compared the ruminal degradation characteristics of the textured and pelleted concentrates that were used in trial 2.

The processing of the textured feed with the higher levels of heat and moisture appeared to decrease the amount of readily available starch and protein and also the overall effective degradability of the protein in the textured concentrate. This decrease in protein degradability in the textured feed probably explains the decrease in protein on a yield/day basis in trial 2 when the animals were fed the textured concentrate. The higher milk fat percentage found in both trial 1 and trial 2 indicates that the feeding of a textured concentrate may lead to increased milk fat production, an effect not noted when feeding the same concentrate in a pelleted form. In trial 1 both milk fat percentage and yield increased when the textured concentrate was fed, while in trial 2, although the milk fat percentage increased when textured concentrate was fed the fat yield did not. The large increase in both fat percentage and yield found in trial 1 may be related to the fact that the animals were fed alfalfa cubes as a forage source, causing a milk fat depressing diet, and under these conditions the feeding of a textured concentrate was able to increase milk fat percent and yield. However, in trial 2 a milk fat depressing diet was not fed and under these conditions the textured feed may not be as beneficial in terms of increasing milk fat production. As well, since only milk fat percentage increased in trial 2, it is hard to say if the increase was due to such factors as increased rumen stimulation from the intact husk or to the subsequent decrease in milk production that occurred when the animals were fed the textured concentrate. Also, the increase in readily available starch in the pelleted feed may help to explain the lower milk fat percentage levels when the animals were fed the pelleted concentrate.

Also of importance is the effect that processing has on intake. In trial 1, no differences occurred in intake between the textured and the pelleted concentrate, indicating no difference in palatability between the two concentrates formulated for this trial. However, in trial 2, both concentrate and silage intake were higher for animals fed the textured ration. This may suggest that the textured ration was more palatable. However, this is not likely as feed refusal and weigh backs only occurred when the textured feed was fed. Also, the increase in concentrate intake is shown on a dry matter basis so this difference may be due to the fact that the moisture content of the pelleted feed was much higher than that of the textured concentrate. As well, the feed, concentrate, fat and protein efficiencies were all higher for the pelleted concentrate.

Therefore, when looking at the overall effects of processing method and how it relates to producers, it would appear that pelleting of the concentrate portion of the ration may be more beneficial than feeding it in the textured form. This is because the current milk pricing system pays producers on a yield and milk fat basis but, with a move towards multiple component pricing (MCP), more focus will be put on other milk components such as protein and lactose/minerals. Thus, in a MCP system a processing technique that can increase both protein and milk yield would be more beneficial to producers than one which may increase fat percentage but also lead to a subsequent decrease in both protein and milk yield.

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