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# Growing Ruminants Fed Rations Containing Bread Wastes: A Review

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## Abstract

In Egypt there is an acute shortage of feed and fodder, being the greatest stumbling block in the improvement of animal production. The cropping pattern shows the heavy dependence on berseem as a winter forage crop with the almost absence of forage in summer rotations. Thus during the December to May period, feeding livestock relies almost entirely on berseem, while for the rest of the year, animals, particularly ruminants, have to survive mainly on crop residues and very small amount of concentrates from extracting oil seeds and milling grains mainly wheat and rice. One of the possible ways of narrowing the gap between the supply and requirements of animal feeds in Egypt is to utilize all agro-industrial by-products which have not yet been used as animal feed. All possible by-products must be integrated with the present feed ingredients to formulate new and suitable rations hoping to approach optimal animal production. Even with maximum utilization of all suitable by-products along with conventional feed ingredients, there will be still insufficient amounts of nutrients to provide adequate requirements for the present animal population in Egypt. Soybean, peanut, and sunflower seeds are widely used for the production of vegetable oils and the remained meals are rich in protein, dietary fibers, and carbohydrates. The major of oilseed meals is used for animal and poultry feeding. The world attention has been directed towards defining and seeking a solution to the problem of diet deficiency. In Egypt and other developing countries, protein shortage and protein caloric malnutrition constitute a prevalent problem. Fiber chemistry is complex and different sources of fiber contain different types of components. Wheat bran, for example, is rich in insoluble components, whereas certain fruits such as apples and citrus fruits are high in soluble fiber (pectin). Inedible wheat flour (IWF) and pasta industry (PW) waste are products that do not comply with the specifications for the flour grade intended for human consumption but have been found to be suitable as feed ingredients in livestock ration. In addition, pasta industry waste (PW) has been estimated at 4-6% of the total annual production of the pasta in Egypt. This review was undertaken to investigate the possibility of utilizing BBy as sources of energy of feed ingredients in rations for growing lambs without reducing animal performance, nutrients digestibilities and feeding values, some rumen liquor parameters, blood constituents and carcass characteristics.

## Keywords

Growing Ruminants, Nutritional, Physiological, Performance, Carcass Traits, Bread Wastes, Residues of Restaurants, Yeast of Baker (Saccharomyces Cerevisiae)

## 1. Introduction

In Egypt there is an acute shortage of feed and fodder, being the greatest stumbling block in the improvement of animal production. One of the possible ways of narrowing the gap between the supply and requirements of animal feeds in Egypt is to utilize all agro-industrial by-products which have not yet been used as animal feed. All possible by-products must be integrated with the present feed ingredients to formulate new and suitable rations hoping to approach optimal animal production. Bread is an important food item in the Egyptian meal. According to Food Balance Sheet [1], cereals play an important role in the diet providing approximately 70% of total calorie intake and two-thirds of protein intake of the low-income families in Egypt.

Various attempts have been carried out to include bread by-products or bakery wastes with different levels in the diet of ruminant animals. Milton and Brandt [2] suggested an optimal inclusion level of below 30% of the diet DM, because of reduced DM intake and increased carcass fatness. However, Huber [3] recommended 10% in feedlot diets. Champe and Church [4] showed increased in digestibility of all dietary components when sheep given diets containing 20 or 40% dried bakery product (DBP) was fed the basal diet. In this respect, Guiroy *et al*. [5] found that bread-byproduct, consisting of rejected bread, can be substituted for up to 75% of whole shelled corn in a growing-finishing beef feedlot diet without reducing meat quality or feedlot performance. Abroad, bread or bakery by-products are common ingredients in the diet of dairy cows. The extent to which these by-products can substitute for grains in ruminant rations is high and increases when the supply of grains is low and the prices are high [6].

In general, bakery wastes are classified according to their chemical composition as a feedstuff with a high concentration of digestible carbohydrates, energy feeds [7, 8].

The main objectives of this study were to investigate the effect of partial replacement of concentrate feed mixture-protein (CFM) by the protein of bread wastes (BW) on growth performance, carcass characteristics, nutrients digestibilities, some blood constituents and rumen liquor parameters of growing lambs.

## 2. Wheat Processing Waste as an Alternative to Feeding Concentrates

Bakery waste (BW) is common ingredients in the diet of ruminants. Bread by-products have resulted as residues human consumption especially from restaurants and student houses in the universities. In general bakery, waste is classified according to thesis chemical composition as a by-product feedstuff with a high concentration of digestible carbohydrates and is referred to as energy feed [7, 8]. Bakery waste is a blended mix of unsold products from bakery and food processing. It is usually in dry form. Its chemical and ingredient composition is highly variable due to sources, products included and fat content of ingredient and regional variability [9, 10].

Bread by-products (BBP) have resulted as remnants human consumption especially from restaurants and student houses of schools and universities are considered as feedstuffs with high energy content. In addition, inedible wheat and pasta industry waste are products that do not comply with the specification for the flour grade intended for human consumption but have been found to be suitable as feed ingredients in livestock ration. Pasta industry waste has been estimated at 4-6% of the total annual production of the pasta in Egypt. It is a processed type (cooked) of wheat flour. Such processing (gelatinization) makes it more susceptible to enzyme attack and hence upgrades its digestibility [11].

Inedible wheat flour (IWF) and pasta industry waste are excellent sources of energy for livestock if included at the proper level in the rations. Inedible wheat flour up to the level of 60% and pasta industry waste up to 50 may be included in the ration of buffalo calves without any advisable effect a digestibility coefficient or feed efficiency of the animals [12].

Dried bakery product (DBP) is a variable mixture made up of surplus and unstable material (dust, fires, unsold products) collected from bakeries and other food-processing plants. DBP is often fed to sharp [4] and poultry [13]; swine [14] and cattle [15].

By replacing 75% of CFM by bread by-product (on DM basis), where bread by-product represented 55% of DM in the diet of steers, Guiroy *et al*. [5] found no digestive problems related to feeding.

Unfortunately, there is a limited recent published literature concerned with chemical composition and nutritive value of bread and its by-products when using it as a feedstuff in feeding farm animals. Therefore, any ingredients used to make bread and likely reflect the variation in its feeding value will be put in our consideration and will have discussed in the following sections.

## 3. The Chemical Composition of Wheat Flour and Wheat-Corn Flour Mixture

The actual nutrient content of a given flour may differ because of the wide variation between plant varieties, processing methods and handling of the flour after processing.

Kent-Jones and Amos [16] reported that the protein content (CP) of wheat flour may vary from 9.0 to 14.0% as a result of raising the extraction degree from 82 to 95%. However, ether's extract (EE) of wheat flour ranged from 1.5 to 2.0% for the 82% extraction flour. They also reported that the starch content of whole wheat was 60-68%, while in wheat flour it was found to range between 65 to 70% for the flour of 72% extraction, 64 to 69% for 80% extraction and to 68% for 85% extraction.

From different wheat varieties, Pomeranz and Hags [17] found that the moisture content was 12.0 to 13.4% ash content 0.35 to 0.7.5 and CP content 8.3 to 13.3% for the 70% extraction flour.

Sidwell and Hammerle [18]; Lorenz and maga [19] and Hallab *et al.* [20], reported that EE of wheat flour varied from 0.1 to 1.08% on the dry matter basis. However, Hussein *et al.* [21, 22] determined the gross chemical composition of 82% extraction of wheat flour and found that crude fat content was 1.25-1.57%, CP 12.35-17.36% crude fiber (CF) 0.42-0.43, starch 77.58% and ash 1.34-1.37%.

The gross chemical composition of wheat flour is independent of the level of extraction. Abou-Raya [23] determining the gross chemical composition of wheat flour 72% extraction imported from the USA and found that it contained 11.05% moisture, 13.03% CP, 2.04% EE, 0.52% CF and 0.59% ash. However, in wheat flour 60% extraction, El-Farra *et al.* [24] found that the CP, EE and ash contents were 11.68, 1.12 and 1.04, respectively.

Makhlouf [25] determined the gross chemical composition of hard wheat flour 72% extraction and found that the components were CF 0.29%, CP 12.71%, ash 0.57% and NFE 82.04%.

For wheat flour 72% extraction, the gross chemical composition was DM 86.8%, CP 12.1%, EE 0.48%, CF 0.51%, starch 73.1% and ash 0.55% [26]. The corresponding percentages were 89.4, 11.4, 0.90, 0.72, 75.2 and 1.2%, respectively as reported by Mekkawy and Hegazi [27].

However, for wheat flour 82% extraction, Mekkawy and Hegazi [27] found that it contained 89.0% DM, 12.6% CP, 1.7% EE, 1.3% CF, 83.0% NFE and 1.5% ash. The corresponding percentages were 88.8, 11.4, 1.3, 0.89, 85.3 and 1.1% as reported by Farghal *et al*. [28].

For whole wheat flour, the chemical composition was 89.2, 12.9, 2.9, 2.6, 69.0 and 1.8% for DM, CP, EE, CF, NFE and ash content [27].

Hussein *et al.* [22] determined the gross chemical composition of maize as follows; moisture 10.14%, CF 4.16%, CP 10.01%, starch 80.46%, reducing sugars 0.40%, non-reducing sugars 2.24%, CP 0.56%, and ash 1.71%; They also studied the effect of addition 20, 30 and 40% of maize flour to wheat flour on the chemical composition of the blended flour, and found that fat, starch, crude fiber and ash slightly increased as the percentage of maize flour was elevated.

EL-Shazly [29] showed that maize flour contained 9.47% moisture, 1.46% ash, 0.85% CF, 3.87% EE, 10.94% CP and 74.26% NFE (on dry weight basis).

Makhlouf [30] found that maize gluten flour which is similar to semolina had the following values of NFE, reducing sugars, non-reducing sugar, starch, CP, ash, CF and EE content; 17.12, 0.46, 3.11, 13.55, 78.68, 1.18, 2.90 and 4.78% respectively (on dry matter basis).

Ibrahim [31] reported that maize gluten had 13.55% moisture, 60.38% CP 9.96% EE, 1.32 % ash, and 28.34% NFE. However, in six samples of maize gluten, Masoud [32] the DM content ranged from 4.95 to 9.24%, CP (46.20-6.12%), EE (3.85-6.89%), CF (1.28- 3.53%) and ash content (1.06-2.39%).

## 4. The Effect of Baking on the Gross Chemical Composition of Shamy Bread

Hussein *et al.* [33] observed that Baladi, Shamy, and Fino bread (Different types of Egyptian bread) contained slightly high percentage (on dry basis) of CP, CF, reducing sugars and ash but markedly had lower quantities of starch of starch and non-reducing sugars compared with the flour. Also, Puchkova *et al.* [34] observed that during bread making the total lipids did not change but the ratio of free and bound lipids was effected. Almost 50% of the lipids were bound to flour constituents. The type of fat added affected the distribution of free and bound lipids. Extensive binding of lipids occurred during dough mixing and baking.

Hussein *et al.* [22, 35] found that Baladi bread manufactured from wheat flour and their mixtures with 20.30 and 40% of maize and sorghum flour, contained lower EE, starch, and non-reducing sugars contents than that of wheat flour, likewise, CP, reducing sugars, CF and ash contents were higher in bread than that of flour. They also indicated that wheat-maize or wheat-sorghum bread had a low amount of protein and non-reducing sugars, but had relatively high quantities of reducing sugars, CF and ash compared with that of wheat bread. The EE was higher in wheat-maize bread than that of wheat-sorghum and wheat bread.

Chung *et al*. [36] found that the lipid binding gradually increased during dough mixing and baking. They also found that the free wheat flour lipids were bound during bread making.

Recently, Mekkawy and Hegazi [27] found that chemical composition was DM 88.0%, CP 12.5%, EE 1.2%, NFE 71.2%, CF 1.2 and ash 1.7% in Baladi bread manufactured from wheat flour 82% extraction versus 87.1, 11.9, 0.92, 72.8, 0.87 and 0.92%, respectively in white bread manufactured from wheat flour 72% extraction.

In dried bakery product, the determined CP and EE were 9.51 and 10.9, respectively [2]. However, the gross chemical composition was DM 91.3%, CP 10.4%, EE 8.5%, NFE 75.5% and ash 3.8% [4].

## 5. The Chemical Composition of Bakery Wastes and Bread By-Products

The nutrient composition of bakery wastes and bread by-products was determined by several authors and was reported by the National Research Council (NRC). Considerable variation was observed, which is depending on the source and method of analysis.

According to NRC [8], BW contained DM 92.0%, CP 10.7%, EE 12.1% and ash 4.4% as compared to 92.0, 5.4, 4.7 and 5%, respectively as reported recently by NRC [37]. In different samples of BW, Arosemena *et al*. [10] found that the corresponding contents were averaged 90.8, 12.3, 8.5 and 3.25%, respectively.

Guiroy *et al*. [5] determined its chemical composition of BBP. They DM, CP, EE and ash contents were 67.6, 16.0, 3.3 and 2.9%, respectively.

In determining the chemical composition of PW, El-Ashry *et al*. [12] found that it contained 90.7% DM, 11.2% CP, 1.0% EE, 79.6% NFE and 8.2% ash. The corresponding contents for inedible wheat flour were 91.0 and 89.8, 9.0 and

10.7%, 2.0 and 1.3%, 1.3 and 1.0%, 86.6 and 85.2%, and 1.1 and 1.8% as reported by El-Ashry *et al.* [12] and [38], respectively.

## 6. Mineral Contents in Wheat Flour, Bread, and Bakery By-Products

Concerning, the mineral content including level of calcium (Ca), phosphorus (P) and potassium (k) are shown in Table 1.

***Table 1.*** *Mineral contents (Ca, P, and K%) in wheat flour, bread, and bakery by-products.*

| Items | Ca % | P % | K % | Authors |
|---|---|---|---|---|
| Wheat flour (72%) extraction | 0.17 | 1.1 | -- | |
| Wheat flour (82%) extraction | 0.32 | 1.5 | -- | [27] |
| Whole wheat flour | 0.48 | 3.18 | -- | |
| Wheat mill run | 0.11 | 1.13 | 1.33 | [37] |
| Baldi bread (82%) extraction | 0.26 | 1.5 | -- | [27] |
| White bread (72%) extraction | 0.18 | 1.20 | -- | [27] |
| Dried Bakery product | 0.28 | 0.32 | -- | [2] |
| | 0.036 | 0.088 | -- | [4] |
| | 0.14 | 0.26 | 0.53 | [8] |
| Bakery waste | 0.1-0.39 | 0.15-0.44 | 0.14-3.73 | [10] |
| | 0.20 | 0.20 | -- | [37] |
| Bread-by product | 0.10 | 0.20 | -- | [5] |

## 7. Effect of Feeding Cereal and Grain Starch as Well as Bread By-Products (BBP) on Animal Performance

### 7.1. Digestibility Coefficients

Site and extent of starch digestion by ruminants varies with species, grain type, and processing method. In cattle, between 18 and 42% of the dietary starch from corn and sorghum grains reaches the small intestine for digestion. With more extensive grain processing, a smaller quantity of starch reaches the small intestine. In the small intestine, 47-88% of the presented starch is digested, while in the large intestine 33-62% of the presented starch is digested [39].

Proper grain processing may markedly enhance starch utilization. However, the extent of improvement is primarily dependent upon the ruminant species, grain sources, and method of processing. Grain processing has less impact on starch digestion by sheep than cattle. Studies comparing processing effects on barley or wheat starch utilization by cattle were not found. Steam flaking consistently improves digestibility of starch by cattle fed corn or sorghum grain-based diets over whole, ground or dry-rolled processes [40].

Processing increases microbial degradation of starch in the rumen and decreases amounts of starch digested post-ruminating. Rates of in vitro amylolytic attack of starch in cereal grains by both ruminal microbial and pancreatic enzyme sources are improved by processing methods employing a proper combination of moisture, heat, and pressure. 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 [40].

The digestibility of a commercial dried bakery product was determined in sheep by Champ and Church [4]. The product was fed at a level of 20 or 40% of the diet and the rest of the diet was composed of alfalfa hay, dried beet pulp and rolled barley. Digestibility of all constituents increased significantly ($p<0.05$) when either 20 or 40% dried bakery product was fed. Calculated coefficients (computed by difference) for the dried bakery product indicated a slight decrease in digestibility crude protein, digestible energy and total dietary nitrogen when the product was fed at the 40% level. The digestible energy was calculated at 4.08 and 3.89 M Cal/ kg for the dried bakery product when fed at 20 and 40% of the diet, respectively.

The effect of feeding pigs either a low-fiber (1.21 g/100 g NDF) or a high fiber (6.38 g/ 100 g NDF) wheat bread as a sole source of dietary protein, Leenaars and Moughan [41] found that the apparent faecal digestibility of gross energy was significantly ($p<0.001$) lower (7.4% units) for animals given the high-fiber bread as was the apparent digestibility of NDF (24 units lower). The apparent fecal digestibility of total nitrogen was also significantly ($p<0.001$) lower for the animals fed the high-fiber bread, but there were no significant differences between the bread her the biological value of their protein.

Green *et al.* [42] found that Rambouillet × Suffolk lambs fed corn wet milling by-product had a higher digestibility of starch than lambs fed dry corn gluten. Starch digestion was higher ($p<0.01$) for lambs fed wet corn gluten *vs* wet corn bran. Dried corn bran increased ($p<0.01$) dry matter digestion compared with wet corn bran.

EL-Ashry *et al.* [12] found that feeding buffalo calves on 40% PW, 20% BL and 40% BH or on 50% PW, 25 BL and 25% BH did not effect on nutrient digestibility as compared to the control ration containing 60% CFM and 40% BH. However, nutritive values in term of DCP was significantly ($p<0.05$) Lower in tested rations compared with the control one.

The effect of type and quantity of starch in rations on apparent and true digestibility of nitrogen in sheep was studied by kreuzer and Kirchgessner [43]. The rations contained constant amounts of N, but different contents of cellulose and two different types of starch (untreated and steam flaked). Content and type of stench did not show any noticeable effect neither on the excretion of undigested dietary N nor on true digestibility. If the rations contained steam-flaked corn starch, the animals showed a lower apparent digestibility.

*In situ* starch degradation of different feeds was perfumed by Cerneau and Michalet-Doreau [44]. They found that the starch digestibility of barley, oats, and wheat bran was found be higher than that of pea and maize, being 98, 97, 96 and

58%, respectively. The particle size variations between feeds ground on the same screen may particle size increased from 0.8 to 6.0mm screen grinding, in situ starch digestibility decreased, the decrease was higher for maize (13.8 points) than for barley (74 points) or pea (10.4 points). Recently, Garnsworthy and Wiseman [45] found that wheat starch was fermented more rapidly in the rumen than starch from maize, barley, potato or sorghum.

The effect of physical treatment of rapeseed expeller, wheat, corn and corn gluten feed on the degradability in the rumen and digestibility was determined by Sommer *et al.* [46]. The treatment of feed decreased significantly the original solubility and theoretical degradability of crude proteins and the amount of undergirded CP increased.

Digestibility coefficients are also affected by differently sized rations. The almost twice lowered size of the normal ration did not improve digestion when the ration had an improper structure. At an appropriate structure, though with a greater size the ration did not lower the level of the digestive and metabolic process, while the coefficients of digestibility substantially rose. The digestibility alone cannot reflect thoroughly the physiology of digestion [47].

Axe *et al.* [48] found that DM digestibility was 77.7 or 87.9% when cattle are given rations containing 80% of sorghum grain or a combination of 40% from sorghum and 40% wheat grain.

Dalke *et al.* [49] studied the effect of wheat middling's (WM) fed as a replacement for either the concentrate or roughage components of finishing diets of steers. They mentioned that DM, OM, and starch digestibilities decreased ($P < .01$) by increasing replacement of dry-rolled corn (DRC) with wheat middling's (WM). Also replacing alfalfa hay (ALF) linearly ($P < 0.01$) increased DM and OM digestibilities. Wheat middling's could replace only up to 5% of DRC without reducing feed conversion efficiency and diet digestibilities, but complete (100%) or partial (50%) replacement of ALF increased digestibilities of DRC finishing diets. Cornett *et al*. [50] found that digestibility of the energy components and CP deceased to rolling on micronizing processing.

Philippeau *et al.* [51] found that differences in the ruminal starch digestion were observed between wheat and corn-based diets and between corn genotypes for dent and flint corns ($P<0.001$) total tract digestion of wheat starch was greater ($P<0.001$) than of corn when fed to steers, while it did not differ between the two corn genotypes. Also, Martin *et al.* [52] reported that hay degradability in the rumen of steers using nylon bags was not affected by the grain source in the diet ($P<0.01$), since total tract digestion of NDF was the same for wheat and for corn diets, averaging 55% for the three diets. They added that a post ruminal composition of NDF digestion (14% of the total tract NDF digestion) seemed to occur with the wheat diet. The lack of any post ruminal NDF digestion (0%) with the two corn diets many suggest digestive interactions in the diet gut similar to those in the rumen.

Zinn [53] found that ruminal digestibilities of OM and starch were similar for dry-rolled wheat (DRW) and steam-rolled wheat (SRW). Post-ruminal and total tract digestibility of OM ($P<0.01$) and starch ($P<0.01$) increased with SRW. Dietary DE and ME values were greater by about 6.1 and 6.6%, respectively; for SRW than for DRW.

Milton and Brandt [54], who found that the replacement of corn with dried bakery product (DBP) on nutrient utilization in steers fed high concentrate diets. Dried bakery product (9.51% CP, 10.9% EE) replaced 0, 15, 30, and 50% of corn (DM basis). Measurements were taken at ad libitum and equalized (% BW basis) intakes. Total tract OM digestibility no effects were evident. Total tract starch digestibility was increased ($P < .01$) and NDF digestibility was decreased by DBP. Dried bakery product decreased long-chain fatty acid (LCFA) digestibility at equal intake. Total tract N digestibility and N retained were unaffected by DBP. Dietary DE was increased by DBP at ad libitum intake, but not during equal intake. When DBP replaced corn, OM intake, and LLCFA and NDF digestibility decreased.

DePeters *et al.* [55] calculated *in Sacco* digestion rates from three different sources of bakery waste for DM and NDF. They reported digestion rates averages of 14.2%/h and 7.1%/h for DM and NDF, respectively.

Guiroy *et al.* [5] obtained a 46% higher rate of digestion for DM for steers fed BBP as compared to that fed corn-based diet. The differences were most likely due to a lower NDF (3.0 *vs* 13.6) and higher nonstructural carbohydrates content in BBP than in corn (75.1 *vs* 65.34) BBP has more rapidly fermentable carbohydrate (starch and sugars).

## 7.2. Growth Performance

Potter *et al.* [13] demonstrated a significant decrease in feed consumption when a diet containing 10% DBP was fed to turkeys.

In steers, Milton and Brandt [2] found a linear depression in DM intake without differences in ADG of steers (1.42, 1.44, and 1.35, Kg respectively) and feed efficiency (0.136, 0.137, and 0.139, respectively) when corn was replaced with dried bakery product (0, 15 and 30% replacement of corn). Dietary NE values, calculated from animal performance, were not affected ($P>.70$) when DBP replaced corn.

In a trial on finishing Rambouillet × Suffolk lambs (29 kg LBW), Kreikemeier *et al.* [56] found that as the level of dry whole corn increased in the diet, average daily gain, feed intake, and feed efficiency was improved ($p<0.01$). The major improvement occurred in the first 30 days of feeding.

Green *et al*. [42] found that Rambouillet × Suffolk lambs (34 kg) fed wet corn gluten consumed less feed than those fed dry corn gluten. Lambs fed wet corn gluten consumed more than those fed wet corn bran. Dried corn bran increased intake compared with wet corn bran. Lambs fed corn wet milling by-products gained faster than lambs fed dry corn gluten. Also, lambs fed wet corn gluten gained faster than those fed wet corn bran.

Shehata and El-Sayed [57] using wheat, corn, barley or concentrate feed mixture based on cotton seed cake in the diets of lambs found that average daily gain (ADG) were

253, 203, 153 and 76 g for lambs fed the previous rations, respectively.

EL-Ashry *et al.* [12] found that introducing pasta industry waste (PW) with level of 40% plus 20% broiler litter (BL) and 40% berseem hay (BH) or with level of 50% PW plus 25% BL and 25% BH did not affect average daily gain and feed intake of buffalo calves as compared to the control ration containing 60% CFM and 40% BH.

Dalke *et al.* [49] fed steers on high-concentrate diets: control (0%); 5, 10, or 15% pelleted wheat middlings (WM) replacing dry-rolled corn (DRC); and 5 or 10% pelleted WM replacing chopped alfalfa hay (ALF) components of the diet. Increasing WM replacement of DRC increased feed: gain ratio (FG; P <.05) linearly.

Guiroy *et al.* [5] found that when steers given rations containing corn and bread by-product, the differences in ADG were not significant. Animals fed bread by-product diet required 8.1% less DM/kg gain than those fed the corn diet indicating higher feed efficiency of bread by-product than corn diet.

Nelson *et al.* [58] found that level of potato by-product (PB) 10 or 20% in diets containing barley or corn quadratically affected gain and matter intake. The gain was faster and feed intake was more for steers fed 10% PB than that fed 20 %PB with corn or barley diets. Corn-fed steers were more (p<0.05) efficient compared those fed on barley diets (5.8 *vs* 6.5 kg DM/kg gain).

### 7.3. Rumen Fluid Parameters

Rumen parameters including pH and concentrations of volatile fatty acids (VFA' s) and ammonia nitrogen ($NH_3$ -N) are important indicators of rumen function, in turn, ruminal fermentation. These parameters are affected by several dietary factors and sampling time.

The results from studies of rumen liquor from cattle and sheep were compared by Jentsch and Wittenburg [59]. In cattle's rumen liquor, the part of acetic acid is on average 2 Mol % and the content of total VFA up to 28 m mol/l higher than in that of weather. The contents of $NH_3$ and urea are lower in cattle than in weather.

#### 7.3.1. Ruminal pH

The value of the ruminal pH is one of the most important parameters, which affects microbial fermentation in the rumen and influences rumen function (Prasad *et al*., 1972). Several authors in regarding the rumen fermentation pattern indicated that ruminal pH value was affected by dietary regimen and sampling time. In this respect, Bakr [60] noticed that the lowest value of ruminal pH value was demonstrated at 3 h post feeding, while pH values returned near to 0 times (highest values) at 6-8 h post feeding.

Rumen pH is one of the most important factors affecting fermentation in the rumen and its function. Rumen pH varies in a regular manner depending on the type of feed and roughage: concentrate ratio. Physically effective fiber is the fraction of feed that simulates chewing activity and stimulates saliva secretion. Bicarbonate and phosphate buffers in saliva neutralize acids produced by fermentation of OM in the rumen. The balance between the production of acids from fermentation and buffer secretion is a major determinant of ruminal pH [61].

Generally, Church [62] reported that rumen fluid pH varies within different sites of the rumen and according to the method of sampling since the denser particles of feed tend to sediment particularly with cattle.

Many research workers reported that the rumen pH was high before feeding with different diets and sharply declined to reach the lowest values at 3 hrs post feeding and increased thereafter [63, 64].

Many research studies cleared that the low rumen pH can seriously damage rumen fermentation of cellulose, since pH values, less than about 6.2 will cause a depression in the degradation rate of fibrous feeds which seems to stop at pH value of about 5.8. These conditions occur mainly in intensive feeding using a large proportion of grain or other rapidly fermenting soluble carbohydrates [65, 66, 67, 68].

Ørskov [69] reported that whole grain diets increased the rumen pH value. It ranged from 5.9 with wheat to 6.7 with oats, but ground grain diet decreased the rumen pH, which ranged from 5 with wheat to 6.1 with maize and eliminated ruminates of lambs. In comparing the effect of concentrates and roughages on ruminal pH of sheep.

Effect of processing of different cereals in lamb diets on ruminal pH was studied by Ørskov *et al*. [70] found that ruminal pH values were almost lower for cereals in grain and pelleted form than in whole loose form. Also, ruminal pH values were different in various types of cereals are shown in Table 2.

***Table 2.*** *Values of ruminal pH were different in various types of cereals Gramineae family.*

| Cereal | Form | Ruminal pH |
|---|---|---|
| Barley | Whole loose | 6.4 |
| | Ground pelleted | 5.4 |
| Corn | Whole loose | 6.1 |
| | Ground pelleted | 5.2 |
| Oats | Whole loose | 6.7 |
| | Ground pelleted | 6.1 |
| Wheat | Whole loose | 5.9 |
| | Ground pelleted | 5.0 |

Roddy and Roddy [71] stated that the pH values were inversely related to the total concentration of volatile fatty acids (VFA) in rumen liquor (RL).

Concerning the effect of dietary factors on pH value in RL. Batajoo and Shaver [72] found that ruminal pH values decreased as dietary non-fiber carbohydrate decreased in diets of Holstein cows

Philippeau *et al.* [51] used balanced diets have the same percentage of starch and crude protein included coarsely cracked cereals to compare the effects of the nature of the cereal (wheat vs. corn) and the corn genotype (dent vs. Flint) on rate, site, and extent of digestion of high–concentrate diets. They found that ruminal mean pH was lower (P<0.01) for wheat for corn-based diets. However, Martin *et at.* [73] noted that large modification in the rumen pH was not visible between the same two corn genotypes used by philippeau *et at*. [51].

### 7.3.2. Buffering Capacity (BC)

Buffering capacity as a rumen fermentation parameter is used as an indicator for the appropriate fermentation procedure. Bc was found to be affected by dietary intake level, the frequency of feeding and chemical and physical characteristics of the diets. These dietary factors also affected saliva production rate, saliva composition and the rate of microbial metabolism in the rumen, which are controlling rumen BC.

Physically, the level of fiber is the fraction of feed that stimulates chewing activity and stimulates saliva secretion. Bicarbonate and phosphate buffers in saliva neutralize acids produced by fermentation of OM in the rumen. The balance between the production of acids from fermentation and buffer secretion is a major determinant of ruminal pH [61].

Nagaraja *et at*. [74] identified the buffering capacity as the ability of the rumen to neutralize excessive acid resulted from the feed (silage and certain by-products feed) or generated during fermentation of diets rich in soluble carbohydrates in the rumen via salivary flow.

As for the numerous complex relationships of pH, its relation to dilution rate emerged. In earlier studies, it was found that dilution rate reduced ruminal pH in steers fed a diet high in roughage, but there was no effect when animals were fed a diet high in concentrate. These results indicated that an alteration in salivary secretion rate in response to the hypertonic sodium chloride solution may differ according to the diet fed and may affect the buffering capacity of the rumen [75].

So, one must remember that there was a close complex interrelationship among rumen BC and factors influencing saliva production which ameliorate the excessive acids of fermenting non-structural carbohydrate. These factors and level in the diet. In this concern, several authors concluded that the buffering cap city in the rumen increased with low-quality roughage in the diet of ruminants, and with concentrate diet as well [76].

Yun *et al*. [77] showed that Holstein cows secreted more saliva during the long rumination time recorded when received 3-12 kg daily allowances of concentrate and this coincided with high pH values.

In sheep, Ead [76] found that BC of rumen liquor recorded higher values with poor quality roughage diets when supplemented with either 30 or 75% concentrate feed mixture than that recorded with good quality roughage or unsupplemented diets. In this respect, Carro *et al.* [78] observed that saliva secretion (L/day) of Merino sheep tended to decrease ($P<0.01$) linearly as the proportion of concentrate in the diet increased above 40%. They added that the lower production of saliva observed for the diets 40:60 and 20:80 is associated with the lower pH values observed for those diets, as lower saliva production would result in a lower buffering capacity of rumen liquor.

EL-Deeb [68] found that BC values in rumen liquor (RL) of sheep significantly decreased ($P<0.05$) from 7.36 to 3.96 and 3.22 meq./100 ml RL when diet was changed prom 100% berseem hay (BH) to 65%BH+35% CMG and 35%BH+65% CMG, respectively. With sampling time, buffering capacity significantly decreased from 6.33 at 0 times (before-feeding) to 4.07 meq./100 ml RL at 8 h post feeding.

### 7.3.3. Ammonia Nitrogen Concentration ($NH_3$-N)

The variations in the concentration of the Rumania $NH_3$-N could be attributed to several factors, level, and degradability of dietary protein, nitrogen source, chemical and physical composition of different contents of the ration and their effects on microbial activity.

Church [79] stated that the normal level of Rumania $NH_3$ N ranged between 10 and 45 mg/100 depending on N-content in the diet and method of analysis used for $NH_3$-N determination. Haaland *et al.* [80] found that concentration of ruminal $NH_3$-N increased by increasing CP percentage the diet, being 10.5, 17.8 and 29.9 mg/100 and of rumen liquor (RL) for three rations containing 11, 14 and 17% CP, respectively. A similar trend was observed by EL-Ashry [81] with different dietary N-level.

Also, wide variation in $NH_3$-N in the rumen could be attributed to the sampling time. It was observed that concentration of Rumania $NH_3$-N reached the highest level (36-40 mg/100 ml RL) 2h post-feeding in sheep [82] and in both goats and buffaloes [83]. The lowest values were noticed 6 h post-feeding [84].

Ruminal ammonia-N is the natural products of rumen degradability of dietary protein to various extents. Moreover, dietary NPN, salivary nitrogen and possibly a fraction of urea entering across the rumen wall are converted almost totally to ammonia. Therefore, several nitrogen sources contribute to ruminal ammonia production.

The rate of NH3 absorption from the ruminal wall was found to affect NH3-N concentration in RL. The increase of $NH_3$ -N concentration in the rumen was mainly attributed to the reduction in $NH_3$ -N absorption by rumen epithelium or to the decrease in the efficiency of microbial protein synthesis [85, 86].

Sanson *et al.* [87] concluded that supplementing low-quality hay with different protein levels increased ammonia-N concentrations in rumen fluid of steers.

### 7.3.4. Volatile Fatty Acids (VFA's) Concentration

The concentration of VFA' s is inversely related to ruminal pH values. Schwartz and Girlchrist [88] reported that a large amount of readily degradable starch provided by the low fiber diet may have promoted the growth of lactic acid producing bacteria in the rumen. The higher concentration of VFA' s is reflected in increasing energy available for microbial protein synthesis and for host animal.

Volatile fatty acids (VFA' s) produced are absorbed and oxidized by the host tissue as the main source of energy. The microbial protein synthesized and dietary ruminal undegradable protein, are the sources of amino acids for the host.

The type of feed consumed mainly governs the rumen fermentation pattern. Acetic, propionic and butyric acids, the main end-products of the fermentation of carbohydrates in the rumen, are the major sources of energy and fulfill important biosynthetic functions in ruminants [89]. Feeding starch-rich diets such as diets high in grains cause increased propionate production, whereas the same absolute amounts but of acetate are produced in case of feeding high roughage diets for ruminants [90].

Generally, the overall fermentation process is advantageous to the host animal when it is fed on roughage diets containing a high proportion of cellulose. On the other hand, when animals fed on cereal diets, fermentation of starch to yield VFA is energetically expensive from the standpoint of glucose supply to the host. This is because of the energy cost of starch digestion in the small intestine followed by absorption of glucose, is low relative to that of hepatic gluconeogenesis from propionate.

Ørskov *et al.* [70] found that follows effects of processing of different cereals in lamb diets on the ruminal proportion of acetic and propionic acids (Table 3).

***Table 3.*** *Effects of processing of different cereals in lamb diets on level the ruminal proportion of acetic and propionic acids.*

| Cereal | Form | Molar proportion of | |
|---|---|---|---|
| | | Acetic acid | Propionic acid |
| Barley | Whole loose | 52.5 | 30.1 |
| | Ground pelleted | 45.0 | 45.3 |
| Corn | Whole loose | 47.2 | 38.7 |
| | Ground pelleted | 41.3 | 43.2 |
| Oats | Whole loose | 65.0 | 18.6 |
| | Ground pelleted | 53.2 | 37.5 |
| Wheat | Whole loose | 52.3 | 32.2 |
| | Ground pelleted | 34.2 | 42.6 |

El-Bedawy [91] found that VFA' s were 11.4 and 11.64 meq/100 ml for lambs fed on concentrate feed mixture and rations containing fat source, respectively.

## 7.4. Blood Constituents

There is a positive correlation between dietary protein levels and concentration of total proteins and their fractions in blood plasma [92] and total protein level in blood reflects the nutritional status of the animal [93]. The high level of globulin may indicate well-developed immunity status [94]. In sheep, Omar [95] found that level of total protein in blood plasma was 8.28 g/100 ml, albumin 3.33 g/100 ml and globulin 4.95 g/100 ml in lambs fed on concentrate and rice straw ad Librium. Kitchalong *et al.* [96] wring Suffolk lamb found that levels of total protein, albumin and globulin were 58.4, 31.7 and 26.7 g/L at 2weeks; 59.5, 35.2 and 24.3 g/L at 7 weeks, and 59.0, 34.8 and 24.2 g/L at 11 weeks of the feeding period.

EL-Sayed *et al.* [97] used Rahmani lambs dividing into 3 groups fed yellow corn (G1), sorghum grain (G2), as the main source of energy representing 50% of the ration or equal combination of both grains (G3). They found that level of total protein in serum was the highest in G3 (7.0 g/100 ml) followed by G2 (6.85 g/100 ml) and G1 showed the lowest values (6.75 g/100 ml). Values of serum albumin showed the same trend, being 3.68, 3.49 and 3.44 g/100 ml in G3, G2 and G1, respectively. Serum globulin, however, did not reach the level of significant among dietary groups ranging between 3.31-3.36 g/100 ml.

EL-Ashry *et al.* [12] using buffalo calves fed a control diet containing 60% concentrate feed mixture (CFM) and 40% Berseem hay (BH, *Medicago sativa*) (G1). In the second (G2) CFM was replaced by 40% pasta industry waste (PW) and 20% broiler litter (BL). The 3rd group was fed on 25% BH, 50% PW and 25% BL. The authors observed that concentration of total proteins and their fractions and cholesterol in blood serum did not differ significantly among the dietary groups. Concentrations of total protein, albumin and globulin were 9.1, 4.0 and 5.2 g/100 ml in G1; 9.1, 4.0 and 5.1 g/100 ml in G2 and 9.2, 3.7 and 5.5 g/100 ml, respectively. However, the level of total cholesterol was 64.4, 54.8 and 52.9 mg/100s ml in G1, G2, and G3, respectively. In general, O'Kelly, [93] reported that the plane of nutrition had no significant in fluorescing on total serum cholesterol values.

Generally, serum creatinine level is useful indicate of glomerular filtration (Kidney function). Blanch and Setchell [98] found that even in fasted sheep, the level of blood creatinine ranged between 0.9 to 1.2 mg /100 ml.

## 7.5. Carcass Characteristics

Many factors have been indicated to influence the carcass characteristics. The most important factors, which affect carcass composition, are animals feeding system and type of diet.

El-Hommosi and Abd El-Hafez [99] tested three energy levels in diets of lambs being high, medium, and low energy levels. They found that lambs fed the high energy level produced heavier cuts than the other two groups.

In ruminants, the effect of diet on meat quality and chemical composition is well recognized. The grain-fed beef has better physical and sensory quality than those of forage fed finished beef, which often has a darker muscle color, deteriorate more rapidly during display and has lower consumer appeal than grain feed. In addition, forage finished beef generally has greater amounts of connective tissue than grain fed beef animals [100]. The same authors studied the feeding sheep on diets of various roughage to concentrate ratios on dressing percentage, meat quality, and composition. Results indicated that as the level of concentrate in the diet increased, there was a non-significant improvement in dressing percentage, this improvement was related to the fat content, which was observed to increase in the kidney. The weights of empty stomachs appeared to be related to the body weight of animals although some influence was noted with increasing levels of roughage in the diets. The weight of the kidney and liver remained unaffected by dietary treatments. With increasing levels of concentrate in the diet, the moisture and protein contents decreased. The decrease in moisture content of meat was associated with a significant ($P<0.05$) increase in fat content.

Taie [101] used the roughage: concentrate ratio of 60:40 to make diets with low or high protein content and low or high fiber content to determine the effect of diets on carcass characteristics. The results revealed that sheep fed high protein diet with both dietary CF levels had significantly heavier body weights. Hot carcass weights were significantly increased ($P<0.05$). Dressing percentages expressed as hot carcass without or with offals based on fasting or empty body weight were affected by differences did not reach a significant level. Sheep fed high protein diets had more lean and less fat percentage. Increasing dietary CP increased carcass protein content. In another study, Taie *et al.* [102] studied the carcass and dressing percentage as affected by the experimental rations of 70:30, 57:43, and 43:57 roughage: concentrate ratio with different levels of energy. Lambs fed high energy diets had a significantly heavier hot carcass, which was significantly increased ($P<0.05$) by increasing the energy levels. Dressing percentages expressed as hot carcass without or with offals based on fasting or empty body weight were affected by varying levels of dietary energy. The dressing percentage as fasting weight and hot carcass weight responded similarly to dietary treatments, but the differences did not reach a significant level. Lean and fat weight were the highest in sheep receiving higher level concentrate and were lowest in sheep fed the lower concentrate level.

Melton [103] showed that the effects of diet ingredients on red meat flavor are dependent on the type of diet, and, to a large extent, on the species: pork, mutton or lamb, and beef. Sensory analysis of meat flavor has been used in most of the studies on the effects of feeds on meat flavor. In general, high-energy grain diets produced a more acceptable or a more intense flavor in red meat than low-energy forage or grass diets. Increasing unsaturation of dietary fat results in a greater flavor change in lamb or beef than in pork. Analyses of lamb and beef produced on different diets have shown that type of feed affects the concentration of many flavor volatile compounds. However, only a few studies have quantified the volatiles of beef and lamb produced on different diets, and no reports of studies were found in which the volatiles of pork produced on different diets had been investigated. Hence, the importance of these changes in volatile concentration to meat flavor has not been determined.

Hassan and El-Feel [104] found that feeding level had no effect on carcass weight dressing percentage and boneless meat ratio. The level of feeding had no significant effect on the composition of the carcass. Also, Abo Ammo [105] found that concentrate intake had no significant effect on carcass weight. The weights of edible offals did not differ significantly although it was better in the high-energy group. The feeding level had no significant effect on lean fat and of the 9-10-11 rib cut.

Murphy *et al.* [106] found that loin primal cut weights decreased with decreasing DM intake by the lambs. On the other hand rack, primal cut weights and shoulder weight were affected by energy intake. They concluded that the net result of restricted feeding increased amounts of lean and decreased amount of fat in carcass cuts. Water content increased by decreasing intake level. While fat was decreased with low energy intakes. Yet, the protein was not affected.

Milton and Brandt [2], found that the replacement of corn with dried bakery product (DBP) resulted in linear increases in KPH ($P<0.5$) and $12^{th}$ rib fat thickness ($P<.10$). Hot carcass weights, dressing percentage, and percent grading choice were not affected ($P<.50$) by DBP inclusion in steers fed the high-energy diets.

Beauchemin *et al.* [107] found that high-energy diets improved carcass weight than low energy diets. Dressing percentage was higher in lambs fed the high-energy diets, but the difference from those fed low energy diets was not significant.

Abdel-Hafez [108] used crossbred lambs (Suffolk × Ossimi) and found that high concentrate diets which contained 83% yellow corn and 15% soybean were significantly effective as regards to empty body weight than the diet containing concentrate feed mixture with roughage (10% wheat straw). The respective percentage was 47.5 – 54.7%.

Guiroy *et al.* [5] found that no differences were observed between the two diets (corn and BBY based) in carcass characteristics ($P > 0.1$). Overall, 78% of the steers graded Choice. Proximate analysis of the *longissimus muscle* (ribeye) steers showed no differences between the two diets for effects on percentage of water, protein, fat, and ash. About 3-5% intramuscular fat reached in 86% of the steers. Correlations were small (not significant) between lipid percentage in the *longissimus* and shear force at d 5, 14, and 21 or with tenderness sensory evaluations. Percentage of lipid in the *longissimus muscle* accounted for 35% of the variations in quality grade and increased as the quality grade increased.

## 8. Conclusion and Recommendations

From the foregoing consequences concerning the lamb performance, physiological responses, and carcass traits of lambs fed BW ration, and from the economical point of view, growing lambs could benefit from diets in which 75% of CFM protein were replaced by BW protein. Without any adverse effects on performance of growing lambs and reduced of pollution.

The present grades draw the attention towards further studies on the inclusion of BW at levels more than that used herein 75% of CFM and demonstrate their effects on productive breeds of ruminants under different management conditions.

Conclusion From the above, The wheat flour is better than the wheat grain, the pasta and its residues are better than the flour for several physical and manufacturing processes, the best of which are all the bread and the fruit, in the nutritional value of the animals fed it as wheat mills, water treatment, and thermal treatment. So I call researchers as a future research point to study all those raw materials and additives feed which are stimulants growth.

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