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Effect of Replacing Corn Grains with Citrus by-product in Concentrate Feed Blocks Form on the Performance and Feed Utilization of Sheep

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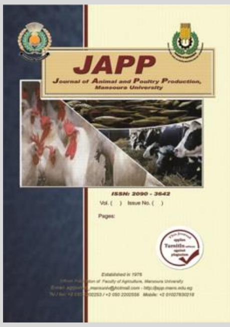

ABSTRACT

Multi-Nutrient concentrate feed blocks were using as a procedure of replacing corn grains with citrus pulp. Blocks were prepared with three replacement percentages: 0, 25 and 50% for Diet 1: served as control, Diet $_2$, and Diet $_3$, respectively. Diets were isocaloric and isonitrogenous with the same roughage concentrate ratio of 30% sugar cane bagasse: 70% concentrate feed blocks. Fifteen Barki male lambs 15.67± 0.30 kg of live body weight (LBW) and 4 months old were divided into three similar groups in a growth trial for 90 days. The results showed that the corn grains revealed a high content of TDN (86.57%), compare with citrus by-product (73.56%). Dry matter consumed was not significantly affected by replacing corn grains with citrus by-product in concentrate feed blocks, almost all digestion coefficients and blood biochemical criteria followed the same pattern, but crude fiber (CF) digestibility were significantly improved by increase the replacement ratio being (65.18, 67.87 and 68.78) for diet$_1$, diet$_2$ and diet$_3$ respectively. Lambs in diet 1 showed higher ($P \leq 0.05$) final body weight FBW, and microbial nitrogen yield (g) than those fed diet 3. Total body gain and average daily gain followed similar trend. Rumen NH_3-N decreased significantly with the concentrations for diets 1, 2, and 3 being 18.87, 18.02, and 17.83 mg/100 mL, respectively. Overall, results suggest that partial replacement of corn grains with citrus by-products, up to 25% in the multi-nutrient blocks, results nearly similar sheep growth performance with no bad effect on digestion coefficients and blood biochemical.

Keywords: Multi-Nutrient concentrate feed blocks, citrus by-product, sheep.

INTRODUCTION

Concentrate feeds are the scarcest, inefficient, and most expensive feedstuff, which limits the amount of livestock that can be farmed in arid and semiarid regions (Al-Jassim *et al.*, 1997).

The increasing demand for animal products in emerg ing nations means that there is a higher requirement for cereals for animal feed that competes with those for human consumption (Delgado *et al*., 2000). Moreover, the increased use of concentrate feeds in the manufacture of biofuel has resulted in a notable rise in their cost (FAO, 2008). According to Shoukry (2019), Egypt's domestic feed grain supply is insufficient to meet the country's animal needs, which amount to 4.2 million tons of total digestible nutrients (TDN) per year. As a result, there is an acute feeding shortage in the country.

The primary problem with animal husbandry in Egypt is the extremely high cost of concentrates and their constituent parts, particularly corn grains, which make up a sizable portion (approximately 50±10%) of the concentrate feed mixture for ruminants that are either imported or locally produced in Egypt. In an effort to deal with this issue, governments continuously import some feed grains and other concentrate feeds. Elevating the use of local feeds (crop wastes, agro-industrial by-products, etc.) is considered a potential way to decrease feed shortages. Simultaneously, there is a rise in feed industrial waste products, like waste citrus pulp, which can be obtained from numerous corporations in the cities of El-Sadat, 10th Ramadan, and 6th October (Habeeb *et al.,* 2011). According to Bampidis and Robinson (2006), citrus species is one of the most valuable fruit crops in the world, and residues from their juice extraction process are used as industrial by-products. According to Hutton (1987), Citrus by-product have a dry matter content ranging from 13–24%, or around 50% of the weight of fresh oranges. However, this might vary from 50–70% depending on the species, variations, husbandry practices, and processing techniques utilized. Hutton (1987) reports that peel (60–65%) and segment pulp (30–35%) constitute the bulk of the dry matter (DM), with seeds make comprise the remainder (0–10%). As compared to other feed ingredients, Citrus by-product are inexpensive, have a high nutritional value (Duoss-Jennings *et al.,* 2013), and are palatable for animals (Gohl, 1978). In addition to having excellent nutrient digestibility, it is rich in antioxidants and vitamin C, both of which benefit the animal's health and the productivity. Depending on DM, it contains 2-5% EE and 7-8.5% CP. Therefore, when utilized as a high-energy feed in ruminant rations to sustain growth and lactation, Citrus by-product have less deleterious effects on rumen fermentation than starch-rich feeds (Bampidis and Robinson, 2006). Various feedstuffs made from citrus byproducts are provided to ruminants (Bampidis and Robinson, 2006). However, in concentrate diets, orange by-product is substituted for grain (Bampidis and Robinson, 2006).

In general, 40–45% of the corn in an airy ration can be substituted with citrus by-product (Arthington *et al.,* 2002). According to Omer and Tawila (2009), the daily body weight gains improved relative economic efficiency, decreased daily

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feeding costs, and increased feed efficiency by replacing yellow corn with a citrus by-product. There are no noticeable variations in the growth of steers fed corn feed meal and citrus by-products if a ration for young, growing steers contains enough protein and other essential elements (Peacock and Kirk, 2003). Citrus by-products have a few disadvantages, including being hard to store when fresh due to their high moisture content (76–87%), which leads to rapid fermentation and sour quickly and, if allow to spoil, becomes a fly breeding ground.

There is growing interest in using citrus by-products as alternative ruminant feeds due to rising disposal costs in various regions of the world (Bampidis and Robinson, 2006). Furthermore, Kammel (1991) calculated the density of citrus by-product to be 324 kg/m^3, whereas Ammerman *et al.* (1965) and Arthington *et al.* (2002) estimated it to be 303 kg/m^3. However, pelleting raises density by around 1.7 and decreases the volume of citrus by-product (Wing, 1975). According to Bakr (2020), citrus by-products can therefore be maintained by ensiling or drying them to maximize their usefulness. Nevertheless, multi-nutrient blocks are another strategy that might be looked into for the preservation of citrus by-products. According to Sancoucy's (1995) reports, feed blocks have been used for livestock feeding since the early 1980s. Citrus by-product can be utilized in place of concentrate corn grain in ruminant feeding in a rapid, simple, economical, accurate, and successful manner (Ben Salem and Nefzaoui, 2003). This reduces the amount of traditional concentrate feed needed and minimizes the impact on the environment. Furthermore, a variety of agro-industrial by-products, particularly those with high moisture content, are used in feed blocks for animal nutrition, which allows for recycling, lowers feeding expenses, and increases availability for human consumption (Molina-Alcaide *et al*., 2020). In accordance with the FAO (2012), the most crucial method of supplying animals with a balanced and complete diet in the future is to use densified completely feed blocks.

The objective of this study was to evaluate the impact on changes in live weight, nutrient consumption, and apparent digestibility of partially replacing the Citrus by-product from growing Barki sheep with corn grains in the form of a Multi-Nutrient concentrate block.

MATERIALS AND METHODS

The current investigation was carried out in the Menoufia University (Shebin El-Kom), Animal Production Department of the Faculty of Agriculture in compliance with Scientific Research Ethics and Animal Use Committee (SRE & AUC) Faculty of Agriculture, Menoufia University (Reference No. 08-SRE & AUC-MUAGR-01-2024).

This investigation was conducted in accordance with the cooperation agreement between the Agriculture By-product Utilization Research Department of the Animal Production Research Institute (APRI) and the Animal Production Department of the Faculty of Agriculture, Menoufia University (Reference No. 2429.22.2019).

Experimental Diets

The Multi-Nutrient concentrate feed blocks in this experiment had Citrus by-product in place of corn grains as describe in Figure 1. Dried Citrus by-product can generally replace 40–45% of the corn in a ruminant feed (Arthington *et al.*, 2002). Table 1 presents the ingredient composition (DM basis) as well as the three distinct Multi-Nutrient concentrate feed block treatments. Combining concentrated ingredients with micronutrients resulted in the tested Multi-Nutrient concentrate feed blocks. To guarantee thorough and even distribution and reduce the danger of toxicity, they were carefully mixed by hand with the binder, which included both quicklime and cane molasses. Each binder was added individually by spraying it after diluting it with water, as Ben Salem *et al*. (2000b) recommendations. Since the hydrophilic nature of the pectin in the waste may be destroyed by adding lime (Ben Salem *et al.*, 2000b). The mixture was firmly compressed well into metal molds that were cylindrical in shape, yielding approximately 2 kg of blocks measuring 20 × 15 cm. The Multi-Nutrient concentrate feed blocks were placed in a well-ventilated, shaded area. They need to be rotated periodically to accelerate the drying process until they are completely dry. Until the animals are given them, the experimental Multi-Nutrient concentrate feed blocks are kept in storage.

Figure 1. shows the shape of the Multi-Nutrient Concentrate Feed Blocks tested in this study

The ingredient composition of Multi-Nutrient concentrate feed blocks (concentrate feed mixture) is shown in Table 1. The chemical composition of the experimental feeds and diets is shown in Table 2. Three diets were isocaloric and isonitrogenous and were prepared with the same roughage: a concentrate ratio of 30:70%. The corn grains were partially replaced by citrus by-product with the Multi-Nutrient concentrate feed blocks tested in this experiment, as follows:

Multi-Nutrient Concentrate Feed Block 1 (MCFB1): 50% ground corn + 0% citrus by product; Multi-Nutrient Concentrate Feed Block 2 (MCFB2): 37.5% ground corn + 12.5% citrus by product; and Multi-Nutrient Concentrate Feed Block 3 (MCFB3): 25% ground corn + 25% citrus by product.

The dry matter percentage in the experimental diets is consistent with the values (87-91%) for various feed blocks reported by Kulathunga *et al.* (2015). Additionally, because citrus by product has a crude protein level (8.54%) that is comparable to corn grain (8.84%), the examined blocks had a crude protein content of almost 14.78%.

Growth trial:

In a growth trial lasting ninety days, fifteen Barki male lambs, with an average of 15.67± 0.30 kg of live body weight (LBW), were grouped into three groups of five at four months old based on their LBW. Animals were fed concentrate feed mixture (CFM) at 3% of their live body weight, whereas sugar cane bagasse plus was *ad-libtum.* Animals were fed to meet their DM requirements in accordance with the NRC (2001). Table 1 provides an illustration of how the experimental concentrate feed mixtures were prepared. Twice a day, at 8 a.m. and 4 p.m., growing lambs were fed in groups. Drinking water was allowed freely all day. Lambs were weighed biweekly in the early morning before the animals were allowed to access feed and water. As body weight changed, the rations that were provided were modified as well. The daily body weight gains and feed conversion ratios were determined by recording the feed intake and final body weight.

Blood samples determination

At the end of the growing trails, blood samples were withdrawn from all the experimental animals four hours after feeding. The serum was obtained by centrifuging the dry jugular vein blood samples for 20 minutes at 4000 rpm. The serum was then frozen at -20°C for further analysis.

Digestion trial

The digestibility study, which was split into two stages: a preliminary 21-day period to allow the animals to adjust to each feed and a 5-day experimental period, was utilized to assess the experimental rations in three Barki rams weighing 43 kg for each treatment. During this trial, the experimental rations were offered at 2% of LBW. The amount of feces per animal was measured and recorded daily, mixed, and 10% representative samples were obtained and immediately frozen at -20°C. Offered feed samples and feces were all well mixed in and oven dried for 48 hours at 70°C. After being processed through a 1 mm strainer, the dried samples of feed and feces were stored for analysis.

Chemical analysis

For proximate analysis, rations and feces were examined (A.O.A.C., 1995). By using difference, nitrogen-free extract was determined. In accordance with Van Soest *et al.* (1991), fiber fractions were analyzed.

Biochemical of blood serum constituents, serum total protein, albumin, urea, aspartate aminotransferase (AST), and alanine aminotransferase (ALT) were determined using commercial kits (Stanbio Laboratory, Boerne, TX, USA) following manufacturer instructions. Subtracting albumin from total protein yielded the globulin value. Rumen fermentation parameters (pH, VFA, and NH_3-N) and samples of rumen liquor were obtained at 6 hours post-feeding using a stomach tube. The ruminal pH was determined immediately using the pH meter (Model HI 8424). Free Ammonia-N in the rumen samples was measured by the Van Slyke method as described by Ahmed (1976), and volatile fatty acids (VFA) were determined by the steam distillation methods as described by Eadie *et al.* (1967).

Statistical analysis

The data pooled through this study was processed by the General Linear Model of SAS software. Statistical analysis (SAS, 2002). Differences among treatments were tested using Duncan (1955). The following statistical model was used:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where,

Y_{ij}= the studied trait, μ = the overall mean, Ti= the effect of treatment i = (1,……5), eij= the experimental error.

Table 1. Ingredients and composition (g/kg, on DM basis) of Multi-Nutrient concentrate feed blocks and feed blocks

Ingredients	Control	Replacement (%)	
		25	50
	Multi-Nutrient Concentrate Feed block 1, (CFB1)	Multi-Nutrient Concentrate Feed block 2, (CFB2)	Multi-Nutrient Concentrate Feed block 3, (CFB3)
Yellow corn grains	50.00	37.50	25.00
Citrus by-product	0.00	12.50	25.00
Soy bean meal	10.00	10.00	10.00
Cotton seed meal	14.00	14.00	14.00
Wheat brain	13.70	13.70	13.70
Primx	0.30	0.30	0.30
Salt	1.00	1.00	1.00
Molasses	5.00	5.00	5.00
Quicklime	6.00	6.00	6.00
Nutrient composition (% of DM) of the experimental Multi-Nutrient concentrate feed blocks			
Dry matter, DM	86.87	86.79	86.71
Organic matter, OM	96.46	96.03	95.59
Crude protein, CP	14.82	14.78	14.74
Crude fiber, CF	6.36	7.44	8.52
Ether extract, EE	3.54	3.47	3.39
Ash	3.54	3.97	4.41
Nitrogen free extract, NFE	71.74	70.34	68.94
Neutral detergent fiber, NDF,	18.00	19.19	20.39
Acid detergent fiber, ADF	8.67	9.74	10.82
Total digestible nutrients (%), TDN*	82.53	80.90	79.27

***Calculation according to Sutardi (2001): TDN=2.79+1.17 CP + 1.74 Fat -0.295 CF + 0.810 NFE**

RESULTS AND DISCUSSION

Chemical composition

The chemical composition of the ingredients (yellow corn grains, Citrus by-product and sugar cane bagasse) and the diets used in this experiment are presented in Table 2. It was observed that the percentage of ether extract (EE) (3.58% and 4.19%) and crude protein (CP) (8.54 and 8.84%) was comparable between citrus by-product and corn grains, respectively. These citrus by-product values are very close to the values approved by Alnaimy *et al*. (2017). However, in this study, the percentage of citrus by-product was higher than that of corn grains by 328.14, 201.16, 95.50, and 216.29%, respectively, in terms of crude fiber, ash, NDF, and ADF.

It is important to note that various factors, such as the fruit's origin, the amount of seeds and peels, the processing method, variations in the production site, the citrus variety, the harvesting season, and the citrus species, can affect the chemical composition of citrus by-product (Hutton, 1987; Arthington *et al.,* 2002; and Wadhwa *et al.,* 2013). However, the corn grains revealed a high content of TDN (86.57%), followed by citrus by-product (73.56%). The energy value of Citrus by-product as a TDN% ranged from 82 to 86% (Arthington *et al*., 2002; Santos *et al*., 2014), compared to 86.2 TDN in ground corn. So, the citrus by-product is a good source of energy in animal rations (Harris *et al.,* 1982).

The values of the chemical composition of citrus by-product in this study were within the ranges found in the literature (Hutton, 1987; Arthington *et al*., 2002; and Wadhwa *et al*., 2013). The tested diets were assigned to be isonitrogenous and isocaloric, with an average of 11.31% and 68.73% for CP and TDN, respectively.

Table 2. Nutrient composition (% of DM) of the ingredients and experimental diets.

	Experimental ingredients			Experimental diets		
	yellow corn grains	**citrus by-product**	**Sugar cane bagasse**	**Diet$_1$**	**Diet$_2$**	**Diet$_3$**
Dry matter, DM	89.32	88.65	90.54	85.17	85.12	85.06
Organic matter, OM	98.28	94.82	96.89	96.59	96.29	95.98
Crude protein, CP	8.84	8.54	3.17	11.32	11.30	11.27
Crude fiber, CF	2.63	11.26	37.31	15.64	16.40	17.15
Ether extract, EE	4.19	3.58	1.14	2.82	2.77	2.72
Ash	1.72	5.18	3.11	3.41	3.71	4.02
Nitrogen free extract, NFE	82.62	71.44	55.27	66.80	65.82	64.84
Neutral detergent fiber, NDF	10.01	19.57	75.76	35.33	36.16	37.00
Acid detergent fiber, ADF	3.99	12.62	58.25	23.54	24.30	25.05
Total digestible nutrients (%), TDN*	86.57	73.56	42.24	70.44	69.30	68.16

***Calculation according to Sutardi (2001): TDN=2.79+1.17 CP + 1.74 Fat -0.295 CF + 0.810 NFE**

Growth performance and feed conversion ratio

Table 3 shows the growth performance, feed intake, and feed conversion of the Barki sheep fed the excremental diets. The initial body weight (kg) (IBW), which varied from 15.35 to 15.91 kg/head, Citrus by-product uses in the Multi-Nutrient block had no significant effect on DMI or dry matter consumption (g/day).

In the present study, the advantages of citrus by-product are an acceptable taste for animals (Gohl, 1978). However, compared to the control diet, there was a linear, non-significant decrease in the consumption of total DM with increasing amounts of citrus by-products. This could be because the diet was bulkier than the citrus pulp, whose bulk density was estimated by Ammerman *et al*. (1965) and Kammel (1991) to be between 303 and 324 kg/m^3. Taniguchi et al. (1999) produced similar results, indicating that feeding diets with different concentrations of dried Citrus by-product had no effect on feed consumption. Whereas McCullough and Sisk (1972), who found a lack of effect on nutrient intake in steers fed different levels (15% and 25%) of dried citrus by-products. The final body weight (kg), FBW, and microbial nitrogen yield (g) were significantly higher ($P \leq 0.05$) in sheep receiving diet 1 than in those fed diet 3. However, the body weight gain (kg/period), WG**,** average weight gain (g/h/day), ADG**,** digestible organic matter fermented in the rumen (g), DOMFR**,** feed conversion ratio, and FCR were significantly higher ($P \leq 0.05$) for diet 1 than for other diets, including citrus by-products. This could be because no significant impacts on nutrient intake were found when Citrus by-product were fed to ruminants, as they had the same energy values as grains (Ahooei et al., 2011).

Table 3. Influence of experimental rations on Barki sheep growth performance, feed intake and feed conversion.

Attributes	Experimental diets			**SEM**	***P*-value**
	Diet$_1$	**Diet$_2$**	**Diet$_3$**		
No. of animals	5	5	5	-	-
Feeding period (day)	90	90	90	-	-
Dry matter intake (g/day), DMI	995.82	967.43	926.09	28.95	0.2692
Initial body wt. (kg), IBW	15.35	15.91	15.76	0.531	0.7477
Final body wt. (kg),FBW	31.99^a	30.04^{ab}	28.63^b	0.708	0.0184
Body wt. gain (kg/period), WG	16.64^a	14.13^b	12.87^b	0.657	0.0050
Av. weight gain (g/h/day), ADG	184.89^a	157.00^b	143.00^b	7.3	0.0050
Feed conversion ratio, FCR	5.386^b	6.162^{ab}	6.476^a	0.338	0.0450
Digestible organic matter in the rumen g/d, (DOMR)*	428.96^a	413.92^b	391.09^c	17.54	0.0286
Microbial nitrogen yield,(g)**	13.73^a	13.25^a	12.51^b	0.588	0.0273

a-b-c etc. Means, within row, with different superscripts are significantly different

***Digestible organic matter in the rumen (DOMR) was assumed to be digestible organic matter multiplied by 0.65 (Masama et al., 1997).**

**** Microbial nitrogen yield = 32g/kg DOMR (ARC 1984)**

Similar results were reported by other researchers (Hadjipanayiotou and Louka, 976; Mart'nez-Pascual and Fernandez-Carmona, 1980b). According to Lanza (1984), Friesian heifers fed dry orange pulp concentrates in half of their corn grain for a period of six to eighteen months did not notice a decrease in body weight. Furthermore, Peacock and Kirk (2003) discovered no significant differences in gain in steers fed ground snapped corn, Citrus by-product and corn feed meal in combination with adequate protein and other essential nutrients in a ration for young, growing steers. On the other side, Henrique *et al.* (1998) found the performance of bulls fed corn in the high concentrate treatment was better than that of bulls fed dried citrus by-products. However, Omer and Tawila (2009) found that body weight gains improved with the replacement of yellow corn with Citrus by-product and improved feed efficiency.

From the results of this experiment, it could be concluded that replacing 25% citrus by-product of corn grain in the concentrated feed of growing sheep did not affect live weight gain. In the same line, according to Gohl (1978), dried citrus pulphave been used as the principal source of energy in the rations of beef cattle and heifers, and calf rations have used up to 45% dried pulp; and the use of up to 55% dried pulp in the diets of young bulls (replacing 86% of maize grain) has no effect on live weight gain (Alnaimy *et al*., 2017). Similar to the findings of Lu *et al*. (2018) revealed that using dry citrus by-product up to 21% of the time had no negative effects on feed intake, body weight growth, or feed conversion ratio.

Overall, the findings indicate that growing lambs were not harmed when corn is partially substituted with citrus by-product in the multi-nutrient blocks in diet 2 compared with the control diet.

Apparent nutrients digestibility

Data on the effect of experimental treatments on digestion coefficients is presented in Table 4. The percentage of digestion coefficients of crude fiber (CF) was significantly improved ($P \leq 0.05$) with Diet $_3$ than Diet $_1$. The acquired results supported the findings of Ben-Ghedalia *et al.* (1989) that citrus by-products, even at large dietary proportions, produce favorable circumstances for cellulolysis in the rumen. Because ruminants are able to ferment high-fiber feeds in the rumen, a considerable variety of citrus by-product can therefore be used in ruminant diets (Grasser *et al.* 1995). Similar consequences, with higher digestibility coefficients for ADF, were noted by Lanza (1984) when starchy diets were substituted for citrus by-products. Additionally, Miron *et al*. (2001) reached the conclusion that feed efficiency is improved and favorable rumen conditions for cellulolysis are created when citrus by-product are partially substituted for dietary corn in the total mixed ratio (TMR) of high-producing dairy cows.

All experimental groups in this investigation had similar overall digestion coefficients, with no significant variations observed. These findings concur with those of Sudweeks (1977), Bueno et al. (2002), and Lanza (1984). Moreover, Ben-Ghedalia *et al.* (1989) investigated the impact on quantitative aspects of sheep digestion of a meal rich in pectin (derived from citrus by-products) compared to a diet rich in starch (derived from barley grains) whereas, the results showed that while the values of OM digestibility were comparable in the two diets, the starch-rich diet's CP was more easily absorbed. In this experiment, the digestibility of the protein in citrus by-product falls between 37% and 70%, which is the range Fegeros *et al.* (1995) found for each variable. In other studies, on sheep digestibility reveal that adding citrus pulp to the diet at levels higher than 30% causes the ration's digestibility to drop (Devendra and Gohl, 1970).

Nevertheless, Mart'nez-Pascual and Fernandez-Carmona (1980) discovered that adding more citrus by-product to the diet of male New Zealand rabbits enhanced the digestibility of dry matter, organic matter, and fiber.

In some other diets containing citrus by-products, the low digestibility of certain nutrients (particularly protein) may be explained by the use of high drying temperatures (i.e., > 140 degrees Celsius), as explained by Lanza (1984). This did not occur in this experiment, however, as multiple nutritional blocks were not processed at that high temperature. On the other hand, Barki sheep with $Diet_1$ had greater ($P<0.05$) total digestible nutrients (TDN) than Barki sheep with $Diet_3$, as reported by McCullough and Sisk (1972), who found the net energy was similar among total mixed rations containing citrus by-product at two proportions (150 and 250 g/kg DM).

Table 4. Nutrients digestibility and feeding value of Barki sheep fed different experimental diets

Attributes	Experimental diets			SEM	*P*-value
	$Diet_1$	$Diet_2$	$Diet_3$		
Nutrients digestibility (%)					
Dry matter, DM	66.26	66.17	65.65	1.780	0.9665
Organic matter, OM	68.61	68.36	67.69	3.118	0.9771
Crude protein, CP	66.31	65.17	65.09	1.521	0.8214
Crude fiber, CF	65.18^b	67.87^{ab}	68.78^a	2.032	0.0459
Ether extract, EE	78.11	77.37	77.25	1.379	0.8936
Nitrogen free extract, NFE	70.46	69.62	68.69	2.234	0.8569
Neutral detergent fiber, NDF,	60.34	62.85	63.18	1.755	0.4860
Acid detergent fiber, ADF	60.17	62.11	64.66	2.739	0.5329
Feeding value (%)					
Total digestible nutrients (%), TDN*	69.73^a	69.13^{ab}	68.39^b	1.76	0.0467
Digestible crude protein, DCP	7.51	7.37	7.34	0.17	0.75

a-b-c etc. Means, within row, with different superscripts are significantly different.
***Total digestible nutrients (TDN, %) = % digestible crude protein + % digestible crude fiber + % digestible N-free extract + (2.25 x % digestible ether extract).**

Blood biochemical profile

Table 5 shows the blood metabolite data of growing Barki lambs fed various experimental diets. In this study, citrus by-product added to sheep diets did not adversely influence immunity under the circumstances of that experiment, as evidenced by the lack of significant changes in the various blood parameter values detected across the experimental groups (Habeeb *et al*., 2011; Lu *et al.,* 2018). Nonetheless, elevated AST levels are an organism's reflecting reaction (Ozardali *et al.* 2004). But the blood parameters in this study revealed a higher trend in total protein, albumin, globulin, creatinine, and urea in $Diet_1$ compared with $Diet_2$ and $Diet_3$ with no significant difference. The liver and kidneys were found to be working normally because every blood parameter evaluated in this study was within sheep's healthy normal standards (Kaneko *et al.,* 1997). Comparable outcomes were noted by Belibasakis and Tsirgoyianni (1996), who detected no appreciable variations in the blood levels of albumin, globulin, and total protein between calves, fed dry citrus by-product and those fed the control diet. Whenever, Hellwing *et al.* (2007) clarified that when the amount of protein in a meal increased, the plasma content of creatinine tended to decrease.

Table 5. Blood parameters of Barki sheep fed different experimental diets.

Attributes	Experimental diets			SEM	*P*-value
	$Diet_1$	$Diet_2$	$Diet_3$		
Total protein (g/dl) , TP	6.84	6.68	6.34	0.254	0.3949
Albumin (g/dl)	3.89	3.75	3.56	0.118	0.1824
Globulin (g/dl)	2.95	2.93	2.78	0.239	0.8614
Alanine transaminase (U/ml), ALT	27.78	28.19	28.28	0.505	0.7623
Aspartate transaminase (U/ml), AST	70.11	70.53	70.71	0.682	0.8185
Urea (mg/dl)	29.12	29.06	28.98	0.802	0.9924
Creatinine (mg/dl)	1.05	0.97	0.92	0.060	0.3408

a-b-c etc. Means, within row, with different superscripts are significantly different.

Rumen fermentation

Rumen fluid measurements for the tested groups are presented in Table 6. The obtained results demonstrated that increasing the amounts of citrus by-product in the diets led to a slight rise in pH values without a significant difference. Leiva *et al.* (2000) found comparable results when assessing the rumen fermentation traits of dairy calves fed corn products or citrus byproducts. Parallel to this, Barrios-Urdaneta et al. (2003) investigated the impact of supplementing with different ratios of barley grain or dried citrus by-product on the rumen fermentation of ammonia-treated straw by ewes. They found that when barley grain and dried citrus by-product were added to the concentrates at up to 833 g/kg, the rumen pH, rumen ammonia concentration, and total VFA concentration were all comparable. Bhattacharya and Harb (1973) also discovered that the rumen pH (6.65) in lambs given corn and dried citrus by-product in different proportions did not vary between treatments. However, Schaibly and Wing (1974) and Pinzon and Wing (1976) discovered that as dried citrus by-product levels in ruminant feeds increased, ruminal pH decreased. On the other hand, citrus by-products, according to Bampidis and Robinson (2006), include 22–40% pectin, which degrades down readily and extensively to produce acetic acid, which is less likely than lactic acid to lower pH and cause acidosis. Because citrus by-product includes a lot of fiber, prolonged ruminating results in large amounts of saliva that acts as a pH buffer for rumen. citrus by-products, then, are seen for animals fed high-concentrate, low-roughage diets, including dairy cows with large yields, to be a safer feed than cereals (Crawshaw, 2004).

While total VFA's (VFA) tended to increase in group with $Diet_1$ compared to the other groups, the differences were not significant. These findings concur with Wing (1975) and Barrios-Urdaneta *et al.* (2003). Moreover, Leiva *et al.* (2000) discovered that treatments of cattle that were fed corn products or dried citrus by-product had comparable ruminal total VFA concentrations in the rumen fluid. Moreover, Ariza *et al.* (2001) found a comparable ruminal VFA content (around 100 mmol/l) when comparing diets high in citrus by-product with diets high in starch. Actually, pectin ferments more quickly than starch (Leiva *et al*., 2000); this could be because it produces more volatile fatty acids and ferments more quickly. On the other hand, Vijchulata *et al.* (1980) observed that ruminal total VFA concentrations were influenced by the energy source when they investigated the impact of citrus by-product in place of corn grain on the ruminal fermentation of steers fed diets containing both corn and citrus by-products.

Table 6. Rumen fluid parameters of Barki sheep fed different experimental diets

Attributes	Experimental diets			SEM	*P*-value
	$Diet_1$	$Diet_2$	$Diet_3$		
pH	6.31	6.46	6.52	0.165	0.6611
Total VFA's, meq/100 Ml	12.95	12.67	12.36	0.204	0.1676
Ammonia-N, mg/100 mL	18.87^a	18.02^{ab}	17.83^b	0.291	0.0596*
Total fungus (x 10^4/ml)	11.93^a	11.81^{ab}	11.69^b	0.057	0.0392*

a-b-c etc. Means, within row, with different superscripts are significantly different.

When citrus by-product was added, Ammonia-N (NH_3-N) dropped significantly ($P < 0.05$), with the rumen fluid's concentrations for diets 1, 2, and 3 being 18.87, 18.02, and 17.83 mg/100 mL, respectively. Comparable patterns were noted by Pinzon and Wing (1976) and Barrios-Urdaneta *et al.* (2003). Citrus by-product often contains little soluble nitrogen, which may cause rumen ammonia to decrease (Alnaimy *et al*., 2017). Further explanation for this could be that the carbohydrates in citrus by-product are more easily broken down by microorganisms, which helps the ruminal bacteria take up ammonia and nitrogen (Hristov and Ropp, 2003). The group with $Diet_3$ showed significantly ($P < 0.05$) lower total fungus than the group with Diet 1. More dietary fiber means a greater number of rumen fungus species (Grenet *et al*., 1989). Citrus by-product is therefore added to ruminant diets as an inexpensive nutritional supplement to prevent the growth of some ruminal bacteria in fluid media, particularly those that are detrimental (Duoss-Jennings *et al.*, 2013).

CONCLUSION

Based on the experiment findings, it can be stated that the performance of growing sheep was unaffected when 25% of the concentrated diet contained citrus by-product instead of corn grain. Moreover, efforts should be made to supply farmers with small-scale apparatus for mixing ingredients, breaking down fodder, and creating feed blocks in order to expand the technology of Multi-Nutrient concentrate feed blocks to the field. Therefore, further work is required to make this technology beneficial for farmers.

REFERENCES

Ahmed, B.M. (1976). The use of non-protein nitrogenous compounds in rabbit ration. M.Sc. Thesis. Tanta univ

Ahooei, G.R; Foroughi, A.R; Tahmasbi, A.M; Shahdadi, A.R. and Vakili, R (2011). Effects of different levels of dried Citrus by-product and urea on performance of fattening male calves. *J. Anim. Vet. Adv*., 10: 1811-1816. https://doi.org/10.3923/javaa.2011.1811.1816

Al-Jassim, R. A. M; F. T. Awadeh, and A. Abodabos. (1997). Supplementary feeding value of urea-treated olive cake when fed to growing Awassi lambs. Anim. Feed Sci. Technol. 64:287–292.

Alnaimy A; A.E. Gad; M.M. Mustafa (2017). Using of citrus pulp in farm animals feeding. *Open Access J Sci* ;1(3):58–67. DOI: 10.15406/oajs.2017.01.00014

Ammerman, C.B.; R. Hendrickson.; G.M. Hall; J.F. Easley and P.E. Loggins (1965). The nutritive value of various fractions of Citrus by-product and the effect of drying temperature on the nutritive value of citrus pulp. Florida Agricultural Experiment Stations Journal Series. 2238:307- 311.

AOAC (1995) Official Methods of Analysis. 14th Edition, Association of Official Analytical Chemists,Washington DC.

ARC., (1984). The Nutrient Requirements of Ruminant Livestock, Suppl. No.1, Commonwealth Agricultural Bureaux, Slough.

Ariza, P; A. Bach; M.D. Stern; M.B. Hall (2001). Effects of carbohydrates from Citrus by-product and hominy feed on microbial fermentation in continuous culture. J. Anim. Sci. (79), 2713–2718.

Arthington. J.D; W.E. Kunkle and A. M. Martin (2002). Citrus by-productfor cattle. Vet Clin North Am Food Anim Pract. 2002;18(2):317–326.

Bakr, M. H. (2020). Citrus by-product as an innovative feed ingredient in ruminant nutrition. A review. *Egyptian J. Anim. Prod. 57 Suppl. Issue, January (2020):73-80*.

Bampidis, V.A and P.H. Robinson (2006). Citrus by–products as ruminant feeds: A review. Animal Feed Science and Technology. 2006;128 (4):175–217.

Barrios-Urdaneta, A; M. Fondevila and C. Castrillo (2003). Effect of supplementation with different proportions of barley grain or Citrus by-product on the digestive utilization of ammonia-treated straw by sheep. Anim. Sci. 76, 309–317.

Belibasakis, N.G; Tsirgoyianni. (1996). Effects of dried Citrus by-product on milk yield, milk composition and blood components of dairy cows. Animal Feed Science and Tech. 1996;60(1–2):87–92.

Ben Salem, H and A. Nefzaoui (2003). Feed blocks as alternative supplements for sheep and goats. Small Rumin. Res. 49:275–288. doi:10.1016/S0921-4488(03)00144-5

Ben Salem, H; A. Nefzaoui and L. Ben Salem (2000a). Supplementing range goats in Central Tunisia with feed blocks or a mixture of *Opuntia ficus indica* var. *inermis* and *Atriplex nummularia*. Effects on behavioural activities and growth. In: Proceedings of the Seventh International Conference on Goats, France, May 15–21, 2000, pp. 988–989.

Ben Salem, H; A. Nefzaoui; L. Ben Salem and J. L. Tisserand (2000b). Deactivation of condensed tannins in *Acacia cyanophylla* Lindl. foliage by polyethylene glycol in feed blocks. Effects on feed intake, diet digestibility, nitrogen balance, microbial synthesis and growth by sheep. Livest. Prod. Sci. 64, 51–60.

Ben-Ghedalia, D; E. Yosef; J. Miron and Y. Est (1989). The effects of starch- and pectin-rich diets on quantitative aspects of digestion in sheep. Anim. Feed Sci. Technol. 24, 289–298.

Bhattacharya, A.N and M. Harb (1973). Dried Citrus by-product as a grain replacement for Awasi lambs. J. Anim. Sci. 36,1175–1180.

Brett, J. R. and T.D.D. Groves (1979). Physiological energetic P. 279-352. IN: W. S. Hoar, D. J. Randall, and Brett, J. R. (eds.). Fish physiology. Volume 8. Bioenergetic and growth. Academic press, New York

Bueno, M.S; E. Ferrari; D. Bianchini (2002). Effect of replacing corn with dehydrated Citrus by-productin diets of growing kids. Small Rumin Res; 46(2–3):179 185.

Crawshaw, R. (2004). Co–product feeds: animal feeds from the food and drinks industries, Nothingham University Press. *J Science of Food & Agriculture*. 83(4):362.

Delgado, C; M. Rosegrant; H. Steinfield; S. Ehui, and C. Courbois. (2000). Livestock to 2020: The next food revolution. IFPRI Brief 61. Int. Food Policy Res. Inst., Washington, DC.

Devendra, C and B.I. Gohl (1970). The chemical composition of Caribbean feeding stuffs. *Trop Agric Trin*. 1970; 4:335–342.

Duncan, D. B. (1955). Multiple ranges and multiple F-test. Biometrics, 11: 1- 42.

Duoss-Jennings, Heather A; Ty. B. Schmidt; Todd R. Callaway; Jeffery A. Carroll; James. M. Martin; Sara. A. Shields-Menard; Paul R. Broadway and Janet R. Donaldson (2013). Effect of Citrus Byproducts on Survival of O157:H7 and Non-O157 *Escherichia coli* Serogroups within *in Vitro* Bovine Ruminal Microbial Fermentations. Research Article | Open Access. International Journal of Microbiology. 2013;1–5. Volume 2013 | Article ID 398320 | https://doi.org/10.1155/2013/398320

Eadie, J. M; P.N. Hobson and S.O. Mann (1967). A note of some comparisons between the rumen content of barley fed steers and that of young calves also fed on high concentrate rations. J. Anim. Prod. 4: 247.

FAO. (2008). Significant increase in world cereal production forecast for 2008, but prices remain high. http://www.fao.org/ newsroom/en/news/ 2008/1000783/ index.html

FAO. (2012). Crop residue based densified total mixed ration. A user-friendly approach to utilize food crop by-products for ruminant production, [by T.K. Walli, M.R. Garg and Harinder P.S. Makkar]. FAO Animal Production and Health Paper No. 172. Rome, Italy.

Fegeros K; G. Zervas and S. Stamouli (1995). Nutritive value of dried Citrus by-product and its effect on milk yield and milk composition of lactating ewes. J Dairy Sci.;78(5):1116–1121.

Gohl, B.I (1978). Citrus pulp for animal feed. In: Ruminant nutrition: Selected articles from the world animal review.FAO:http://www.fao.org/docrep/004/x6512e/X 6512E0 8.htm#ch8.

Grasser, L.A; J. G. Fadel and I. Garnett (1995). Quantity and economic importance of nine selected by–products used in California dairy rations. *J Dairy Sci*.;78(4):962–971.

Grenet E; A. Breton; P. Berry and G. Fonty (1989). Rumen anaerobic fungi and plant substrate colonization as affected by duet composition. Animal Feed Science and Technology 26:55-70

Habeeb. A.A.M; A.E. Gad and A.A. EL Tarabany (2011). Effect of two climatic conditions and types of feeding on body weight gain and some physiological and biochemical parameters in crossing calves. Zagazig vet J.;39(3):34 48.

Hadjipanayiotou, M and A Louka (1976). A note on the value of dried Citrus by-productand grape marc as barley replacements in calf fattening diets. Anim. Prod. 23, 129–132.

Harris, B; M.B. Olyaiwole; S.D. Sklake and K.C. Bachmn (1982). Citrus Feedstuffs for Dairy Cattle.Florida Agricultural Experiment Station. Bull. 829.

Hellwing, A.L.F; A.H. Tauson and A. Skrede, A (2007). Blood parameters in growing pigs fed increasing levels of bacterial protein meal. Acta Veterinaria Scandinavica, 49: 33

Henrique, W; P.R. Leme; D.P.D. Lanna; J.L.V. Coutinho-Filho; R.M. Peres; C.L. Justo; P.A. de Siqueira and G.F. Alleoni (1998). Replacement of starch for pectin in diet with different concentrate levels. 1. Animal performance and carcass characteristics. Rev. Bras. Zootec. 27, 1206–1211.

Hristov, A.N and J.K. Ropp (2003). Effect of dietary carbohydrate composition and availability on utilization of ruminal ammonia nitrogen for milk protein synthesis in dairy cows. J Dairy Sci.;86(7):2416–2427.

Hutton, K (1987). Citrus by-product in formulated diets. Recent Advances in Animal Nutrition. Pp: 297- 316. Available at: http://livestocklibrary.com.au/handle/1234/19532

Kammel, D.W (1991). Physical characteristics of alternative feeds (as stored, handled and fed). In: Proceedings of the Alternative Feeds for Dairy and Beef Cattle Symposium, St. Louis, MO, USA. 111–116 pp.

Kaneko, J. J; J. E. Harvey and W. J. Sitelu (1997). Clinical Biochemical of Domestic Animals 5th ed. Harcourt Barce and Company Asia PTE. LTD. 989-899.

Kulathunga, K., Shantha, K. and Nayananjalie, W. (2015). Preparation of cattle feed blocks using agricultural wastes. International Journal of Multidisciplinary Studies. 2: 73-79

Lanza, A (1984). Dried Citrus by-product in animal feeding. In: J Hollo, editor. Proceedings of the International Symposium on Food Industries and the Environment Budapest. Hungary, New York, USA; 1984. p. 189 198.

Leiva, E; M.B. Hall and H.H. Van Horn (2000). Performance of dairy cattle fed Citrus by-product or corn products as sources of neutral detergent-soluble carbohydrates. J. Dairy Sci. 83, 2866–2875.

Lu, J; X. Long; Z. He; Y. Shen; Y. Yang; Y. Pan; J. Zhang and H. Li (2018) Effect of dietary inclusion of dried Citrus by-product on growth performance, carcass characteristics, blood metabolites and hepatic antioxidant status of rabbits, J of Applied Animal Research, 46:1, 529-533, https://doi.org/10.1080/09712119.2017.1355806

Martınez-Pascual, J; J. Fernandez-Carmona (1980). Citrus by-product in diets for fattening lambs. Anim. Feed Sci. ´ Technol. 5, 11–22.

Masama, E; J.H. Topps; N.T. Ngongoni and B. Maasdorp (1997). Effects of supplementation with foliage from tree legumes Acacia angustissima, Cajanas cajan, Calliandra calothysus, and Leuceana leucocephala on intake, digestibility and nitrogen metabolism of sheep given corn stover ad. lib. Animal Feed Science Technology. 69: 233-240.

McCullough, M.E and L.R. Sisk (1972). Crude fiber, form of ration, type of silage and digestibility of optimum rations. J. Dairy Sci. 55, 484–488.

Miron, J; E. Yosef and D. Ben-Ghedalia (2001). Composition and in vitro digestibility of monosaccharide constituents of selected byproduct feeds. J. Agric. Food Chem. 49, 2322–2326.

Molina-Alcaide, E; E. Y. Morales-Garcia; A. I. Martin-Garcia; H. Ben Salem; A. Nefzaoui and M. R. Sanz-Sampelayo. (2020). Effects of partial replacement of concentrate with feed blocks on nutrient utilization, microbial N flow, and milk yield and composition in goats.J. Dairy Sci. 93 :2076–2087 doi: 10.3168/jds.2009-2628

NRC (National Research Council) (2001). Nutrient requirements of dairy cattle (7th ed.). National Academies Press. Washington, DC, USA, 381 pp. DOI: https://doi.org/10.17226/9825.

Omer, H.A.A and M.A. Tawila (2009). Response of Baladi Goats to diets containing different levels of citrus by–product. Egyptian J Nutrition and Feeds. 12(1):75–88

Ozardali I; M. Bitiren; A.Z. Karakilçik; M. Zerin; N. Aksoy and D. Musa (2004). Effects of selenium on histopathological and enzymatic changes in experimental liver injury of rats. Exp Toxicol Pathol. 56:59–64.

Peacock, F.M and W. G, Kirk (2003). Comparative feeding value of dried citrus pulp, corn feed meal and ground snapped corn for fattening steers in dry lot. Animal Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Science. University of Florida, USA; 2003

Pinzon, F.J and J.M. Wing (1976). Effects of Citrus by-product in high urea rations for steers. J. Dairy Sci. 59, 1100–1103.

Santos, G. T; L.S. Lima; A.L.B. Schogor; J.V.De. Romero; F.E. Marchi; P.A. Grande; N.W. Santos; F, S. Santos and R. Kazama (2014). Citrus by-product as a dietary source of antioxidants for lactating holster in cows fed highly polyunsaturated fatty acid diets. Asian Austral as. J. Anim. Sci., 27 (8): Pp1104-1113.

SAS (2002). Statistical Analysis Systems Institute Inc., Release 8.1, Cary, NC., USA.

Schaibly, G.E and J.M. Wing (1974). Effect of roughage concentrate ratio on digestibility and rumen fermentation of corn Silage-Citrus by-product rations. J. Anim. Sci. 38, 697–701.

Shoukery M.M. (2019). The possibility of using some unconventional feed resources as a source of energy and protein in feeding livestock. Egyptian J. nutrition and feeds. 22(2) special issue. P1.

Sudweeks, E.M (1977). Digestibility by sheep of diets of citrus pulp, corn, or soybean mill feed with three forages. J. Dairy Sci. 60, 1410–1415.

Sutardi T (2001). Revitalisasi peternakan sapi perah melalui penggunaan ransum berbasis limbah perkebunan dan suplementasi mineral organik. Laporan Akhir RUT VIII.I. Kantor Menteri Negara Riset dan Teknologi dan Lembaga Ilmu Pengetahuan Indonesia. Jakarta

Taniguchi, K; Y. Zhao; H. Uchikawa; T. Obitsu (1999). Digestion site and extent of carbohydrate fractions in steers offered by-product diets, as determined by detergent and enzymatic methods. Anim. Sci. 68, 173–182.

Van Soest, P.J; J.B. Robertson and B.A. Lewis (1991). Methods of Dietary Fiber, Neutral Detergent Fiber and Non-Starch Polysaccharides in Relation to Animal Nutrition. J. of Dairy Sci., 74, 3583-3597. http://dx.doi.org/10.3168/jds. S0022-0302(91)78551-2.

Vijchulata, P; P.R. Henry; C.B. Ammerman; S.G. Potter; A.Z. Palmer; H.N. Becker (1980). Effect of dried Citrus by-product and cage layer manure in combination with monens in on performance and tissue mineral composition in finishing steers. J. Anim. Sci. 50, 1022–1030.

Wadhwa, M; M.P.S. Bakshi and H.P.S. Makkar (2013). Utilization of fruit and vegetable wastes as livestock feed and as substrates for generation of other value-added products. RAP Publication FAO., Pp 67.

Wing, J.M (1975). Effect of physical form and amount of Citrus by-product on utilization of complete feeds for dairy cattle. J. Dairy Sci. 58, 63–66.

تأثير إحلال حبوب الذرة بتفل الموالح فى صورة قوالب مركزات علفية على الأداء والاستفادة الغذائية للحملان

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الملخص

في هذه الدراسة، تم تكوين قوالب علفية مركزة متعددة العناصر الغذائية لدراسة تأثير استبدال حبوب الذرة بمخلفات تقلل الموالح حيث تم استبدال حبوب الذرة بتفل الموالح داخل قوالب المركزات العلفية بثلاثة نسب استبدال 0، 25، و50% . تم استخدام ثلاثة علائق : عليقة 1 (عليقة ضابطة) ، عليقة 2 وعليقة 3 بنفس ترتيب نسب الاستبدال ، حيث كنت الثلاث علائق متساوية السعرات الحرارية ومتساوية النيتروجين وتم تحضيرها بنفس نسبة المادة المركزة الى الخشنة 70% قوالب العلف المركز : 30% تفل مصاصة القصب . استخدم 15 حمل برقى عمر 4 شهور بمتوسط وزن 15.67 ±0.30 كجم و تم تقسيم الحملان الى ثلاث مجاميع لاجراء تجربة النمو التى استمرت لمدة 90 يوم ثم تجربة الهضم. اظهرت النتائج أن نسبة البروتين الخام (8.84% و8.54 %) كانت متقاربة بين حبوب الذرة وتفل البرتقال على التوالي، ومع ذلك، احتوت حبوب الذرة عن نسبة عالية من TDN (86.57%) مقارنة بتفل البرتقال (73.56٪). لم يكن لتفل البرتقال بالبلوكات العلفية المركزة تأثير كبيرعلى حجم الاستهلاك من المادة الجافة (جم / يوم)، أو كل معاملات الهضم ماعدا معاملات الهضم للألياف الخام ((CF) والتى تحسنت معنويا (P ≤ 0.05) مع العليقة الثالثة مقارنة بالعيقة الاولى. فى حين كان وزن الجسم النهائى (كجم) وإنتاجية النيتروجين الميكروبي (جم) أعلى معنويا (P ≤ 0.05) في الأغنام التي تغذت على العليقة الاولى مقارنة بتلك التي تتغذى على العليقة الثالثة. مع زيادة نسبة ادخال تفل البرتقال بالعليقة ادى إلى ارتفاع طفيف في قيم pH الكرش وكانت الفروق غير معنوية فى المقابل اتخذت قيم الاحماض الدهنية الطيارة الاتجاه المعاكس بدون وجود فروق معنوية ايضا، فى حين انخفضت نسبة الأمونيا (NH_3H) بشكل معنوى (P <0.05) حيث بلغ تركيزاتها بسائل الكرش فى الحيوانات التى تغذت على العليقة 1 و2 و3 القيم التالية 18.87 و18.02 و17.83 ملجم/100 مل على التوالي. بشكل عام، تشير النتائج إلى أن الاستبدال الجزئي لحبوب الذرة بتفل الموالح، بنسبة تصل إلى 25% في البلوكات العلفية المركزة الغنية بالعناصر الغذائية لم يؤثر سلبيا على اداء نمو الحملان دون ظهور الى تأثيرات سلبية على قياسات الدم ، معاملات الهضم و أداء الحيوانات