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INFLUENCE OF FEEDING DRIED ORANGE PULP ON BODY WEIGHT CHANGES, DIGESTIBILITY, BLOOD CONSTITUENTS AND IMMUNITY STATUS OF CALVES AND SHEEP

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ABSTRACT: The current study was carried out to evaluate the effect of replacing yellow corn with dried orange pulp (DOP) at three various levels, 15, 30, and 45%, on body weight changes, blood biochemical parameters, and immunity status of cross-breeding Barahama & Zibo calves (experiment 1). Moreover, to determine digestibility, rumen fermentation, nitrogen balance, and blood criteria of Barki sheep (experiment 2). Four experimental rations (C, R15, R30, and R45) were prepared in total mixed ration (TMR) with a similar roughage: concentrate ratio of 30:70% (70% concentrate feed mixture (CFM) + 20% corn silage + 10% wheat straw) on DM basis. Animals in the control group received TMR without dried orange pulp (C). Calves on R15, R30, and R45 received TMR included 15, 30, and 45% of the dried orange pulp in part as a replacement of yellow corn grains. Animals in the two experiments received the same previous rations in four comparable groups. The obtained results showed that calves on R15 (15% dried orange pulp) recorded the highest values of final body weight (FBW), average daily gain (ADG), and total gain (TG), being 456 kg, 1.49 kg, and 89.3 kg, respectively. They were followed by C (453.8, 1.46, and 87.8 kg), R30 (444.6, 1.44, and 86.3 kg), and R45 (446.9, 1.42, and 85.4 kg), respectively, with no significant differences among experimental groups. DOP was more effective in increasing the daily profit percentage relative to control, with values of 19.40, 9.42, and 15.24% for R15, R30, and R45, respectively. Digestion coefficients of DM, CP, CF, and EE were not significantly affected by adding DOP. However, the digestibility of NFE increased (P= 0.02), being 71.46, 72.13, 71.98, and 71.95% for C, R15, R30, and R45, respectively. Nitrogen balance (NB) values were not significantly affected by dietary treatments, being 8.16, 8,00, 7.97, and 8.18 g/d for C, R15, R30, and R45, respectively. TDN did not differ significantly, being 65.74, 66.70, 66.00, and 65.98% in the same respective order. The DCP value followed the same pattern. The values of rumen pH were significantly (P=0.045) decreased by increased dried orange pulp levels at 2 hours post feeding, being 6.33, 6.19, 6.16, and 6.12 mg/dl for C, R15, R30, and R45, respectively. Total rumen VFA was significantly higher (P<0.01) at 2 hours post feeding for R30 and R45, being 14.66 and 14.87 meq/dl, respectively, than C and R15 rations. Rumen NH_3-N in R45 was significantly higher (P=0.038) at 2 hours after feeding, being 18.52 than C, R15, and R30 (18.11, 18.30, and 18.37 mg/dl, respectively). All blood biochemicals, hematological, and immune parameters were not significantly affected by DOP. Generally, the partial replacement of yellow corn grains in the CFM formula with orange pulp that has been dried didn't adversely affect Barahama & Zibo calves' body weight changes as well as digestibility, nutritive value, and nitrogen balance of Barki sheep, without any adverse effect on liver and kidney functions, and immunity status. DOP had greater efficiency in increasing the daily profit margin in fattening calves' rations and can take place of yellow corn grains up to 45%.

Keywords: Orange pulp, calves, sheep, yellow corn, performance.

INTRODUCTION

The global production of oranges in 2023/2024 was estimated at 48.8 million metric tons, and the largest producers were Brazil, China, and the United States. Production increased by 1.1 million metric tons of fresh oranges compared to 2012/ 2013. Egypt is the fifth largest producer of fresh orange in the worled in 2023/2024, and its production was approximated at 3.7 million tons. Egyptian production was increased in 2013/ Jul 2014 to 2.570 million tons (USDA, 2024). Citrus is mostly produced in the Mediterranean nations of

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Turkey, Italy, Spain, Greece, Morocco, and Egypt (24%), followed by Brazil (24%), and the United States (21%). When fruit is processed into juice, pulp is a byproduct. In Turkey, 4 769 726 tons of citrus (orange, tangerine, lemon, grapefruit, and orange) were produced (Tuik, 2017). Citrus waste poses a risk of environmental contamination due to its ability to contaminate air, soil, and water, release unpleasant odors, and harbor insects (Palangi *et al.,* 2013; Iftikhar *et al.,* 2019). However, citrus wastes can be used throughout the year in ruminant feeding following various methods of preservation without undergoing any chemical changes (Ali *et al*., 2015; Nayel *et al*., 2024). It has a nutritive value comparable to any conventionally used energy-rich concentrates in animal feeding, so it has great potential to be used in animal rations (Alnaimy *et al.,* 2017). The substitution of cereals up to 61% with citrus pulp in goat rations has no adverse effects on performance and may reduce the cost of production (López *et al.,* 2014).

Habeeb (2023) demonstrated that citrus pulp is rich in various energy sources that support the growth of ruminant microorganisms, comprising soluble carbohydrates and a fraction of neutral detergent fiber that is readily digestible, as well as a large number of readily fermentable carbohydrates, which contribute to its high nutritional value. NDF and ADF digestibility is increased when starchy diets are replaced with citrus by-product feeds. In addition to being a great feed for beef and developing cattle, dried citrus pulp may substitute energy sources in rations to the extent that it is permissible to incorporate it into as much as 40% of the dry matter without endangering the health of the animals. He also reported that citrus pulp can be dried to maximize its utility and can be fed to heifers up to 45% as the major source of energy. By-products of citrus are used as an inexpensive dietary supplement to cow diets, and it has been shown that supplementing with citrus byproducts may reduce the development of Salmonella and Escherichia coli in mixed microorganism fluid medium in the rumen (Jennings *et al.,* 2013). Citrus byproduct feedstuffs are becoming more popular as an alternative to traditional feeds for ruminants because of rising disposal prices in many world regions. For ruminants, the main citrus by-product feeds are citrus pulp, citrus silage, dried citrus pulp, citrus meal and fines, citrus molasses, citrus peel liquor, and citrus-activated sludge. Culls or extra fruit are two minor citrus by-product feedstuffs. Citrus by-product feedstuffs are a high-energy feed that can be used in ruminant diets to promote development and lactation in comparison to starch-rich feeds (Bampidis and Robinson, 2006). In this regard Allam *et al*. (2021) reported that blood parameters of the experimental cows remained within the normal range for various constituents, including platelets, red blood cells (RBCs), hematocrit, hemoglobin (Hb, g/dl), alanine transaminase (ALT), aspartate transaminase (AST), total protein (g/dl), albumin (g/dl), creatinine (mg/dl), and urea. However, a significant decline ($P \leq 0.05$) in white blood cells (WBCs) and globulin levels was observed as the proportion of dried citrus pulp (DOP) in the diet increased. Rahman *et al.* (2023) revealed that using dried citrus pulp at (0, 10, 15, and 20%) levels decreased the price of total mixed ration from 32.37 to 29.8 pounds per kg of TMR. El-Sheikh *et al.* (2024) estimated the effect of replacing corn grains with citrus pulp at (0, 25, and 50%) levels in Barki lamb's diets. Feed intake, body weight gain, and average daily gain were decreased ($P \leq 0.05$) with increased dried citrus pulp levels. Recently Al-Adawy *et al.* (2024) revealed that replacing yellow corn grains with dried citrus pulp at levels (0, 30, and 60%) did not affect DM, OM, EE, and NFE digestibility. However, CP digestibility was declined ($p \leq 0.05$), but CF digestibility was increased ($p \leq 0.05$) with increased dried citrus pulp levels.

This study's aim was to assess the impact of substituting dried orange pulp (DOP) for yellow corn at three distinct levels, 15, 30 and 45%, on body weight changes, blood biochemical, and immunity status of cross-breeding Barahama & Zibo calves. Moreover, to determine digestibility, rumen fermentation, nitrogen balance and blood criteria of Barki sheep.

MATERIAL AND METHODS

This research was carried out in compliance with Scientific Research Ethics and Animal Use Committee (SRE & AUC) Faculty of

Agriculture, Menoufia University (Reference No. 20-SRE & AUC-MUAGR-‘7-2024), in order to partially substitute citrus orange pulp for yellow corn in the rations of calves and sheep.

Feeding experiments

The current study was carried out in two feeding trials; the first one was carried out to determine the effect of the replacement of yellow corn with dried orange pulp in three different levels, 15, 30 and 45%, on body weight changes, blood biochemical, and immunity status of cross-breeding Barahama & Zibo calves (experiment 1). In order to clarify the results of the first experiment regarding the nutrient utilization as affected by dried orange pulp replacement level, it was thought that it is better to re-design another digestion trial on sheep to determine the nutrient digestibility, nutritive values, nitrogen balance, and rumen fermentation (experiment 2).

Experiment one

Animals, rations and feeding procedure

Forty cross-breeding Barahama & Zibo calves at eleven months old and a live body weight of 360±7 kg were used in a completely randomized design for two months as an experimental period. The animals were divided into four comparable groups (10calves/group) according to their live body weight. The calves were fed to meet their requirements according to (NRC, 2000). Four experimental rations (C, R15, R30, and R45) were prepared in TMR form with the same roughage: concentrate ratio of 30:70 % (70% CFM + 20% corn silage + 10% wheat straw) on DM basis. Animals in the control group received a concentrate feed mixture (CFM) without dried orange pulp (C). Calves on R15, R30, and R45 received CFM that included 15, 30 and 45% of the dried orange pulp as a partial replacement of yellow corn grains. According to the change in body weight, the daily feed allowance was changed quantitatively. Calves were weighted biweekly before morning feeding to determine body weight changes. Feed is provided twice daily at 7:00 a.m. and 16:00 p.m. Fresh water was available at all times. The concentrate feed mixture formula of the experimental rations is presented in Table 1.

Table 1: Concentrate feed mixture formulation of the experimental rations.

Ingredients	Experimental rations			
	C	R15	R30	R45
Yellow corn	47	39.95	32.9	25.85
Wheat bran	13	10	7	6
Soybean meal 46%	16	17	18	19
Cottonseed	4	4	2.7	2
Sugar beet gain	4	3.5	1	0.5
Dried orange pulp	0	7.05	14.1	21.15
Dried barley waste	3	2.5	1	1
Soybean peel	6	2	1	1
Molasses	1	4	5	6
Glutified 16%	2	6	13.5	14
Calcium carbonate	1.5	1.5	1.3	1.3
Sodium chloride	1	1	1	0.8
Vitamins	0.1	0.1	0.1	0.1
Mineral salts	0.2	0.2	0.2	0.2
Antitoxin	0.1	0.1	0.1	0.1
Sodium bicarbonate	0.7	0.7	0.7	0.7
Pantonite	0.4	0.4	0.4	0.3

C served as control group: - 70% CFM + 20% corn silage + 10%wheat straw. R15: Control ration with replacing 15% of yellow corn with dried orange pulp. R30: Control ration with replacing 30% yellow corn with dried orange pulp. R45: Control ration with replacing 45% of yellow corn with dried orange pulp

Economic indicators

The cost analysis of feeding and other economic indicators, expressed in Egyptian pounds (L.E.), was derived from the prevailing market prices of the ingredients during the study period, which spanned from August to October 2022. The prices were assigned as follows: C 8675 L.E. /ton, R15 8486 L.E. /ton, R30 8293 L.E. /ton, R45 8000 L.E. /ton, and 68.5 L.E. / kg of live calve.

Experiment two

Animals, feeds and feeding

In order to determine digestibility and nitrogen balance, sixteen Barki rams with an average live body weight of 50 kg ± 2.25) were used in a digestibility trial. Sheep were fed to meet their DM requirements according to NRC (1985). The previous four experimental rations in experiment one were prepared with the same three replacement levels (Table 2). The animals were divided into four comparable groups according to their live body weight and fed individually in digestion metabolic cages as described by Maynard *et al*. (1979). Water was available at all times throughout the experimental period. The experimental period consisted of a 21-days preliminary period and another five days for quantitative collection of feces and urine.

Sampling and analytic procedure

The chemical composition of ingredients and experimental rations are presented in Tables 2. The proximate analysis of ingredients, rations, and feces was carried out according to AOAC (2000).

To determine nitrogen balance, urine was collected in containers containing 100 ml of HCl (10%) to maintain *p*H < 2.00 to avoid N loss through ammonia volatilization and to avoid bacterial growth in the urine. Rumen liquor samples were obtained at 0, 2, and 4h post-feeding using a rubber stomach tube inserted into the rumen via the esophagus. Samples were filtered through four layers of cheesecloth and subsequently homogenized, and *p*H was immediately determined. Then, a preservative was added to keep ammonia nitrogen unchanged. Some of the liquor was stored in a deep freezer (-20^{o}C) until chemically analyzed using dried glass bottles with adding 0.5 ml toluene and 1 ml paraffin oil to each sample. The preservation of the rumen liquor samples for the determination of ammonia nitrogen (NH3-N) was performed in accordance with the described methodology outlined by Preston (1995). The analysis of volatile fatty acids (VFA) was performed using the steam distillation techniques established by Eadie *et al*. (1967).

Blood samples were collected at the end of each experiment in two tubes at 2 hr. post feeding via the jugular vein puncture from all calves (experiment one) and rams (experiment two). The first tube to separate the blood plasma so it contains ethylene tetra acetic acid (EDTA) to prevent blood clotting to determine hematological parameters (Kolmer *et al*., 1951). The other tube was for separating blood serum, so it was without anti-coagulant and centrifuged at 3500 rpm for 20 minutes, then analyzed for serum biochemical parameters using standard kits supplied by Spectrum, Germany. Immunoglobulin A, immunoglobulin G concentrations and Interleukin 2 in serum were determined using single radio-immuno-diffusion methods derived primarily from the works of Fahey and McKelvey (1965) and Mancini *et al.* (1965).

Statistical analysis

The analysis of the data was conducted utilizing the Statistical Analytical System (SAS, 2002), Version 9.3.1, in accordance with the General Linear Model as detailed below.

$Y_{i\ j} = \mu + T_i + e_{ij}$ where: $Y_{i\ j}$ = the parameters under analysis. μ = the overall mean. T_i = the treatment effect (i = 1 …and 3).e_{ij} = the random error of means. Differences among means were evaluated using Duncan's (1955) Multiple Range test.

Table 2: Chemical composition of the ingredients, and experimental rations.

Item	Ingredients					Experimental ration[2]			
	CFM	Yellow corn	Orange Pulp	Corn silage	Wheat straw	C	R15	R30	R45
DM, %	90.12	90.01	88.92	34.58	89.9	67.23	66.82	66.68	66.55
Nutrients % on DM basis									
Organic matter, OM	92.46	91.09	91.72	91.07	88.40	90.80	90.64	90.07	90.13
Crude protein, CP	15.6	7.8	7.88	8.35	2.29	12.81	12.84	12.92	13.00
Crude fiber, CF	7.9	4.52	14.2	21.83	40.11	13.80	13.9	14.11	14.31
Ether extract, EE	3.19	2.02	4.75	3.15	3.25	3.18	3.1	3.23	3.14
Nitrogen free extract, NFE	65.77	76.75	64.89	57.74	42.75	61.01	60.8	59.81	59.68
Ash	7.54	8.91	8.28	8.93	11.60	9.20	9.36	9.93	9.87

CFM: concentrate feed mixture in control group. C: served as control group received 70% CFM + 20% corn silage + 10%wheat straw. R15: Control ration with replacing 15% yellow corn with dried orange pulp. R30: Control ration with replacing 30% yellow corn with dried orange pulp. R45: Control ration with replacing 45% yellow corn with dried orange pulp

RESULTS AND DISSCUSION

Effect of dried orange pulp on:

Calves body weight changes

In order to determine growth performance, forty cross-breeding Barahama and Zibo calves were used in a growth trial. The influence of feeding distinct levels of dried orange pulp on the change in body weight of calves throughout the experimental period is shown in Table (3). The average of the initial body was almost equal in all groups. The body weight of all calves in the experimental groups continued to increase throughout the experiment period. However, differences were not significant between the experimental calves regarding their body weight. Calves on R15 (15% dried orange pulp) recorded the highest values of final body weight (FBW), average daily gain (ADG), and total gain (TG) being 456kg, 1.49kg, and 89.3kg, respectively, differences among all groups were not significant for respective values. Calves in all experimental groups were in a good growth performance with no significant differences, which demonstrates that the body weight change of calves was unaffected by the partial substitution of dried orange pulp for yellow corn.

It has been reported that the impact of dried orange pulp on the animals' body weight change varies as the partial replacement of yellow corn with dried orange pulp without significant effect (Lanza *et al*., 2015). Evan *et al*. (2020) conducted an assessment on the impact of substituting cereals and protein concentrates in a high-cereal diet for light lambs with a byproduct concentrate comprising 18% corn distiller's dried grains with soluble (DDGS), 18% dried citrus pulp (DCP), and 8% exhausted olive cake (EOC). The findings indicated that there were no significant differences in the final body weight (BW) and average daily gain (ADG) among the different groups. Rahman *et al.* (2023) observed that including dried citrus pulp at (0, 10, 15, and 20%) levels in goat diets did not affect feed intake, BWG, and ADG in all groups. In contrast, orange pulp significantly increased total body gain and average daily gain (Bueno *et al.*, 2002; Javed *et al*., 2016; Lashkari *et al.*, 2017; Francisco *et al*., 2017; Sayed and Ghobashy, 2018; Costa *et al.*, 2019, Rahman *et al.*, 2023).

Furthermore, Tadayon *et al.* (2017) demonstrated that increasing dried citrus pulp levels in the lambs' diet improved DMI and ADG. The simultaneous feeding of 220 g/ kg DM of dried citrus pulp resulted in the best animal performance. Bueno *et al.* (2002) found a similar trend, concluding that replacing 40% of corn with DCP can attain the best performance for growing kids. On the other hand, Sousa *et al.* (2020) conducted an assessment of various feeding diets, including a control diet consisting of ground corn (GC), a diet with a partial substitution of GC by ground citrus pulp (GCP), and another with a partial replacement of GC by pelleted citrus pulp (PCP). The findings indicated that heifers receiving the GC diet exhibited higher final body weight (BW), average daily gain (ADG), and dry matter intake (DMI) in comparison to those fed with citrus pulp. Additionally, the inclusion of ground citrus pulp was found to enhance DMI and fiber intake relative to the PCP group. Kutay and Kutlu (2022) studied the Effect of supplementation dried citrus pulp at (0, 7.5, 15, and 22.5%) levels in dairy goat's ration. Citrus pulp utilization increased dry matter intake significantly ($P \leq 0.05$) and negatively impacted changes in body weight.

Table 3 : Calves body weight changes as affected by the dietary treatments.

Item	Treatment				*SEM*	*P*-value
	C*	R15	R30	R45		
Body weight, BW						
Initial BW	366.1	366.7	358.3	361.5	4.29	0.89
BW 15 day	392.7	392.6	380.4	381.5	4.29	0.61
BW 30 day	417.3	416.9	402.8	401.8	4.26	0.40
BW 45 day	430.5	430.4	419.5	423.4	4.49	0.79
Final BW	453.8	456.0	444.6	446.9	4.62	0.80
ADG	1.46	1.49	1.44	1.42	0.026	0.85
TG	87.8	89.3	86.3	85.4	1.58	0.84
Economic indicators[1]						
Price of daily gain, LE	100.01	102.06	98.64	97.27	-	-
Total daily feed cost, LE	81.97	80.52	78.90	76.48	-	-
Daily Profit, LE	18.04	21.54	19.74	20.79	-	-
Relative daily profit, %	100	119.40	109.42	115.24	-	-
Improvement, %	0.0	19.40	9.42	15.24	-	-

*Group 1(C) control group, 70% CFM + 20% corn silage + 10% wheat straw. Group 2 (R15): control ration with 15% yellow corn replaced with dried orange pulp. Group3 (R30): control ration with 30% yellow corn replaced with dried orange pulp. Group 4 (R45): control ration with 45% yellow corn replaced with dried orange pulp. SEM: standard error of means

[1]Prices (from August to October 2022) were assigned as follows; C 8675 L.E / ton, R15 L.E. 8486 L.E / ton, R30 8293 L.E / ton, R45 8000 L.E / ton and 68.5 L.E. / kg of live calve.

Daily profit, LE = price of daily gain – total daily feed cost

Relative daily profit, %= (Daily profit / daily profit of Control) *100

[a, b, c] means within each raw with different superscript differ significantly

Otherwise, El-Sheikh *et al.* (2024) reported that feed intake, body weight gain, and average daily gain were decreased ($P \leq 0.05$) with increased dried citrus pulp levels.

Economic indicators of calves

The economic indicators were assessed for the groups of calves that were provided with the experimental finishing diets in the current study,

as presented in Table 3. The R15 revealed the highest daily gain and total gain being 1.49 kg/d and 89.3 kg, respectively, followed by C (1.46 and 87.8), R30 (1.44 and 86.3), and R45 (1.42 and 85.4), respectively with no significant differences between all experimental rations. From these results, it could be concluded that employing dried orange pulp in place of yellow corn grain in the ration of Barahama & Zibo calves was more effective in increasing the daily profit percentage relative to control, being values 19.40, 9.42, and 15.24% for R15, R30, and R45, respectively. This was due to the low price of dried orange pulp compared with yellow corn grains, and the calves in all experimental groups were in good growth performance with no discernible variations between the experimental groups (Lanza *et al*., 2015; Evan *et al.,* 2020). Relative cost-effectiveness and availability of alternative raw materials determine how much DCP is used in feed formulation (Hutton, 1987). Citrus byproducts are used as a low-cost dietary addition to cow diets, and it has been shown that supplementing with citrus byproducts may reduce the development of Salmonella *and Escherichia coli* in mixed microorganism fluid medium in the rumen (Jennings *et al.,* 2013). Partial replacement of corn by DCP (10% or 20 %) in TMR of high-producing dairy cows improved feed efficiency (Miron *et al.*, 2002). Caparra *et al.* (2007) replaced 30% and 45% cereal grains with solar DCP in ration of Iamb. They discovered a cost reduction per kilogram of body weight gain, which was roughly 11% for the solar DCP-45 group and 18% for the solar DCP-30 group. Also, In Egypt, Allam *et al.* (2011) concluded that 50% of corn grains could be replaced by DOP as an alternative source of energy for growing lambs' rations to reduce the cost ratio (feed cost/ kg gain, LE) by 8.6%. In contrast, Gholizadeh and Naserian (2010) evaluated the 7% and 14 % replacing barley grains by DCP in rations of Iranian Saanen kids. They found that feed efficiency did not differ between treatments. Also, Ahooei *et al.* (2011) assessed how DCP replaced 12% of the barley grains in the diets of fattening male calves. The feed conversion ratio (FCR) of the experimental ration containing 12% DCP was found to be negligible when compared to the control ration. Allam *et al.* (2021) reported that economic efficiency (LE) was significantly ($P<0.05$) increased by increasing the replacement level of yellow corn grains with dried orange pulp. In the same context, Rahman *et al.* (2023) revealed that using dried citrus pulp at (0, 10, 15, and 20%) levels decreased the price of total mixed ration from 32.37 to 29.8 pounds per kg of TMR.

Digestibility

In order to clarify the results of the first experiment regarding the nutrient utilization as affected by dried orange pulp replacement level, it was thought that it is better to re-design another digestion trial on sheep to determine the nutrient digestibility, nutritive values, nitrogen balance, and rumen fermentation.

Table 4 presents the nutrient digestibility of sheep as affected by feeding dried orange pulp. The addition of dried orange pulp soared ($P= 0.02$) the digestibility of NFE compared with the control group being 71.46, 72.13, 71.98, and 71.95 for C, R15, R30, and R45. However, the differences between treatment groups were not significant. It is clear from the data in Table (4) that varying amounts of dried orange pulp used to replace yellow corn (15, 30 and 45%) had no significant effects on DM, CP, CF, and EE digestibility; this finding agrees with Bueno *et al.* (2002) who discovered that digestibility of OM, CP, and NFE were insignificantly affected by increasing dried orange pulp level. Sayed and Ghobashy (2018) reported that digestibility of DM, OM, CP, CF, EE, and NFE were not affected by increased treated citrus pulp levels in growing Barki lamb's diet. Furthermore, Allam *et al*. (2021) showed that there were insignificant ($P>0.05$) differences among all nutrient digestibility, except the digestibility of nitrogen-free extract, which was significantly ($P\leq0.05$) decreased by increasing the replacement level of DOP to more than 25% (R2).

Javed *et al.* (2016) demonstrated that increasing addition of dried citrus pulp to the buffalo ration enhanced the digestibility of DM, CP, NDF, and ADF (Tadayon *et al.,* 2020).

Zedan and Khattab (2017) reported that DM, OM, CP, and EE digestibility were not affected, but CF and NFE digestibility were significantly increased ($P \leq 0.05$) with increased dried citrus pulp levels. On the other hand, Sharif *et al.* (2018) obtained that no significant differences in DM and OM digestibility; however, CP digestibility decreased with increased dried citrus pulp levels. Habeeb (2023) demonstrated that citrus pulp contains a variety of energy substrates for ruminant microorganisms, including soluble carbohydrates and an easily digested neutral detergent fiber fraction, as well as a large number of readily fermentable carbohydrates, which contribute to its high nutritional value. NDF and ADF digestibility increased when starchy diets were replaced with citrus byproduct feeds. In addition to being a great feed for beef and developing cattle, dried citrus pulp may substitute energy sources in rations to the extent that it can be added to up to 40% of the dry matter without endangering the health of the animals. Recently, Al-Adawy *et al.* (2024) determined the Effect of yellow corn grains replaced by dried citrus pulp at levels (0,30, and 60%) on digestibility in lactating buffalos. Results revealed that digestibility of DM, OM, EE, and NFE were not affected by treatments. However, CP digestibility was decreased ($p \leq 0.05$), but CF digestibility was increased ($p \leq 0.05$) with increased dried citrus pulp levels.

Nitrogen balance

Nitrogen balance results are presented in Table 4. Rams fed all experimental rations had almost similar nitrogen intake, being 31.6, 31.82, 31.79, and 32.16 g/d for C, R15, R30, and R45 rations, respectively. Animals on different experimental rations released almost equal amounts of N in the feces and urine, being 11.18, 10.94, 11.35, and 11.02 g/day in feces and 12.26, 12.88, 12.47and 12.97 g/day in urine for C, R15, R30, and R45 respectively. The close values of fecal nitrogen from different groups could be attributed to the fact that crude protein digestibility of all experimental rations was insignificant. The NB values were not significantly affected by dietary treatments, being 8.16, 8.00, 7.97, and 8.18 g/d for C, R15, R30, and R45, respectively. It was obvious that all sheep fed on the four tested experimental rations had positive nitrogen balances. It is noticeable that NB was unaffected significantly when varying amounts of dried orange pulp were substituted for yellow corn. This result is consistent with crude protein digestibility. Also, this may be due to rations was isonitrogenous and nitrogen feed intake was insignificant between all experimental rations. Similarly, Sharif *et al.* (2018) observed that nitrogen balance was not affected by substituting dried citrus pulp at (10, 20, 30, and 40%) levels in lamb's diet. In contrast Javed *et al*. (2016) revealed that nitrogen balance was increased ($P<0.05$) with increasing dried citrus pulp in buffalo ration. Also, Evan *et al*. (2020) indicated that the nitrogen balance improved when cereals and protein concentrates in a high-cereal diet for lambs were replaced with 18% distillers dried grains with solubles (DDGS), 18% dried citrus pulp (DCP), and 8% exhausted olive cake (EOC) within a byproduct concentrate.

Nutritive value

It is well known that nutrient digestibility is considered one of the basic measurements to determine feeding value. Data in Table 4 presented the nutritive value of the experimental ration as affected by replacing yellow corn with different levels of dried orange pulp. TDN did not differ significantly among experimental rations, being 65.74, 66.70, 66.00, and 65.98%. Also, DCP values followed the same pattern, being 7.73, 7.77, 7.83, and 7.89% for C, R15, R30, and R45, respectively. This may be attributed to that most nutrients digestibility was insignificant, especially crude protein digestibility.

Sayed and Ghobashy (2018) reported that TDN and DCP followed the same trend of DM, OM, CP, CF, EE, and NFE digestibility, which were not affected by increased citrus pulp levels in growing Barki lamb's diet. On the other hand, Zedan and Khattab (2017) investigated the Effect of replacing corn grains with dried orange pulp at (0, 50, 75 and 100%) levels in goat rations; they reported that TDN was increased ($P \leq 0.05$) and DCP was decreased ($P \leq 0.05$) with increased dried citrus pulp level.

Table 4: Digestibility, nitrogen utilization and nutritive value of the experimental rations as affected by the dietary treatments

Item	Treatment				*SEM*	*P*- value
	C*	R15	R30	R45		
Digestibility (%)						
DM	66.72	66.50	66.48	66.39	0.08	0.58
CP	64.62	65.63	64.30	65.73	0.07	0.57
CF	65.31	66.87	66.12	66.23	0.28	0.30
EE	73.11	73.16	73.21	73.21	0.03	0.73
NFE	71.46[b]	72.13[a]	71.98[a]	71.95[a]	0.09	0.02
Nitrogen utilization (g/d)						
N in Feed	31.6	31.82	31.79	32.16	0.42	0.980
N in Feces	11.18	10.94	11.35	11.02	0.17	0.348
N in Urine	12.26	12.88	12.47	12.97	0.17	0.938
NB	8.16	8	7.97	8.18	0.52	0.791
Nutritive value (%)						
DCP	7.73	7.77	7.83	7.89	0.22	0.215
TDN	65.74	66.70	66.00	65.98	0.44	0.915

*Group 1(C) control group, 70% CFM + 20% corn silage + 10% wheat straw. Group 2 (R15): control ration with 15% yellow corn replaced with dried orange pulp. Group3 (R30): control ration with 30% yellow corn replaced with dried orange pulp. Group 4 (R45): control ration with 45% yellow corn replaced with dried orange pulp. SEM: standard error of means

[a, b, c] means within each raw with different superscript differ significantly

Rumen fermentation

Data in Table 5 shows that replacing yellow corn grains with dried orange pulp at different levels (0, 15, 30, and 45) had no significant impact on the rumen pH values at zero time being, 6.41, 6.42, 6.45 and 6.51 for C, R15, R30 and R45 rations, respectively. Rumen pH values at 2 hours post feeding were significantly ($P=0.045$) decreased by an increase in dried orange pulp levels, being 6.33, 6.19, 6.16, and 6.12 for respective rations. At four hours after feeding, pH values followed a similar trend to those at 2 hours, but the differences among experimental rations were insignificant. Total VFA was significantly higher ($P<0.01$) at 2 hours post feeding for R30 and R45, being 14.66 and 14.87 meq/dl, respectively, than C and R15 rations, with no significant difference between them. The lowest value was obtained with the control ration being 14.49 meq/100 ml. Total VFA values at 0 and 4 hours were not significantly affected by experimental rations. It is obvious that total VFA values within all the experimental rations increased post-feeding to reach the highest level at four hours post-feeding. There was significant effect ($P<0.01$) among studied rations on rumen NH_3-N at 2 hours after feeding as response to increased orange pulp level. R45 recorded 15.52 mg/dl, which was significantly higher than C, R15, and R45, being 18.11, 18.30, and 18.52 mg/dl, respectively, with no significant difference between R15 and R30, but significantly higher than the control ration. NH3-N concentration at 0 hours was not significant for all experimental rations compared to the control. It is obvious that all NH_3-N concentrations within all the experimental rations increased post-feeding to reach the highest level at 2h and decreased thereafter. In this regard Sayed and Ghobashy (2018) revealed that ruminal pH was not affected by increased dried citrus pulp levels, ruminal TVFA concentration was increased with increased dried citrus pulp levels, rumen NH_3-N concentration was reduced ($p \leq 0.05$) with increased dried citrus pulp level. A comparable pattern was discovered by Tayengwa *et al.* (2021), who reported that using

citrus pulp at 150g in steers feeding did not affect rumen pH, However TVFA significantly increased ($p \leq 0.05$), especially acetic and isovaleric acid, and NH_3-N significantly ($p \leq 0.05$) decreased. Also, Steyn *et al.* (2017) observed that rumen pH and TVFA were unaffected by feeding Jersey cows citrus pulp. However, NH_3-N was increased significantly ($p \leq 0.05$). In the same trend, Evan *et al.* (2020) revealed that rumen pH and TVFA were not different from the control diet. However, NH_3-N was decreased ($P \leq 0.05$) in treatment compared to control diet. Tadayon *et al.* (2017) reported that rumen pH was unaffected by increased dried citrus pulp levels in the lamb's rations, while TVFA concentration increased significantly ($p \leq 0.05$), and NH3-N concentrations were reduced ($p \leq 0.05$) with increased dried citrus pulp level in lambs' diet. Conversely, Rodríguez *et al.* (2020) reported that feeding dried citrus pulp (DCP) diet increased rumen pH, with no significant impact on NH3-N. Recently El-Sheikh *et al.* (2024) demonstrated the impact of replacing corn grains by varying amounts of citrus pulp in the diets of Barki lambs at (0, 25, and 50%) levels. Rumen pH and TVFA were not significantly different. However, rumen NH_3-N and total fungus were increased significantly ($P \leq 0.05$) with increased dried citrus pulp levels.

Table 5: Rumen parameters of sheep as affected by the dietary treatments.

Incubation time	Experimental rations				SEM	*P*- value
	C*	R15	R30	R45		
Rumen liquor pH						
0	6.41	6.42	6.45	6.51	0.04	0.832
2h	6.33b	6.19^{ab}	6.16^{a}	6.12^{a}	0.03	0.045
4h	6.30	6.25	6.24	6.21	0.02	0.306
NH_3-N, mg/dl						
0	16.61	16.66	16.64	16.57	0.03	0.859
2h	18.11^{b}	18.30^{ab}	18.37^{ab}	18.52^{a}	0.06	0.038
4h	18.95	18.87	18.98	18.89	0.07	0.257
TVFA, meq/dl						
0	12.86	12.82	12.88	12.94	0.03	0.683
2h	14.49^{b}	14.53^{b}	14.66^{a}	14.87^{a}	0.06	<0.001
4h	16.33	16.24	16.23	16.20	0.03	0.390

*Group 1(C) control group: 70% CFM + 20% corn silage + 10% wheat straw. Group 2 (R15): control ration with 15% yellow corn replaced with dried orange pulp. Group3 (R30): control ration with 30% yellow corn replaced with dried orange pulp. Group 4 (R45): control ration with 45% yellow corn replaced with dried orange pulp. SEM: standard error of means

$^{a, b, c}$ means within each raw with different superscript differ significantly

Blood biochemical parameters

Data in the following Tables 6, and 7 represent blood biochemical parameters of calves and sheep as affected by dried orange pulp. The results illustrated that the concentration of biochemical blood parameters of the experimental groups did not show significant differences due to feeding the calves or rams on dried orange pulp. Data revealed that there were no significant differences in serum total protein, albumin and globulin levels as affected by the experimental groups. The values of serum AST, ALT, urea, and creatinine were insignificant as affected by dried orange pulp. Generally, the values of all tested blood biochemical parameters were within the normal range, indicating that dried orange pulp in the present study did not have any adverse effect on either liver or kidney functions. No differences were found among tested treatments for all parameters measured.

Table 6: Blood biochemistry of calves as affected by the dietary treatments.

Item	Treatment				*SEM*	*P*- value
	C*	R15	R30	R45		
Total protein (g/dl)	7.30	7.30	7.73	7.46	0.10	0.437
Albumin (g/dl)	3.97	3.97	4.40	4.13	0.07	0.076
Globulin (g/dl)	3.33	3.33	3.33	3.33	0.06	1.000
A/G ratio	1.19	1.19	1.33	1.24	0.03	0.403
ALT(U/l)	32.67	34.67	35.00	36.67	0.58	0.154
AST(U/l)	87.00	86.66	83.33	85.08	0.76	0.137
Urea(mg/dl)	46.66	47.00	45.33	47.00	0.29	0.106
Creatinine(mg/dl)	1.98	1.92	1.95	1.92	0.01	0.238

*Group 1(C) control group, 70% CFM + 20% corn silage + 10% wheat straw. Group 2 (R15): control ration with 15% yellow corn replaced with dried orange pulp. Group3 (R30): control ration with 30% yellow corn replaced with dried orange pulp. Group 4 (R45): control ration with 45% yellow corn replaced with dried orange pulp.
AST: Aspartate transaminase; ALT: Alanine transaminase. SEM: standard error of means.

Table 7: Blood biochemistry of sheep as affected by the dietary treatments.

Item	Treatment				*SEM*	*P*- value
	C*	R15	R30	R45		
Total protein (g/dl)	7.40	7.21	7.80	7.16	0.10	0.111
Albumin (g/dl)	4.33^{ab}	4.04^{c}	4.47^{a}	4.11^{bc}	0.06	0.018
Globulin (g/dl)	3.06	3.17	3.32	3.04	0.06	0.412
A/G ratio	1.41	1.28	1.34	1.35	0.03	0.322
ALT(U/l)	36.66	35.33	36.66	37.33	0.57	0.717
AST(U/l)	63.33	64.33	65.66	62.33	0.81	0.573
Urea(mg/dl)	41.33	42.66	42.33	42.00	0.92	0.974
Creatinine(mg/dl)	1.44	1.45	1.24	1.40	0.05	0.466

*Group 1(C) control group, 70% CFM + 20% corn silage + 10% wheat straw. Group 2 (R15): control ration with 15% yellow corn replaced with dried orange pulp. Group3 (R30): control ration with 30% yellow corn replaced with dried orange pulp. Group 4 (R45): control ration with 45% yellow corn replaced with dried orange pulp.
AST, Aspartate transaminase; ALT; Alanine transaminase. SEM: standard error of means

Our results were interconnected with the findings by Allam *et al.* (2011), who studied the Effect of substituting DOP up to 50% for corn grains in sheep rations on blood parameters (total protein, total lipid, cholesterol, ALT, AST, uric acid, Urea-N, and creatinine). They detected non-significant differences for all blood plasma parameters among treatments, and the values for all rations were within the normal range. In the same trend, in rations of Iranian Sannen kids,

Oni *et al*. (2008) reported a significant increase ($P < 0.05$) in total protein and serum glutamate oxalate transferase (SGOT) levels as the ratio of citrus pulp in the diets was elevated, in comparison to the control diet. The liver uses ammonia taken up from the rumen to synthesize urea; consequently, the concentration of urea N in the serum is closely linked to the concentration of NH3-N in the rumen (Davidson *et al*., 2003 ; Abo-Donia *et al*., 2022).

Zedan and Khattab (2017) examined the Effect of replacement corn grains by dried orange pulp at (0, 50, 75, and 100%) levels on blood parameters in goat rations. Blood serum analysis indicated that replacing corn grains with dried citrus pulp did not produce any notable changes in the levels of total protein, albumin, globulin, creatinine, liver function indicators (ALT, AST), and total cholesterol. However, it was observed that the concentration of urea significantly rose exclusively at the 100% dried citrus pulp inclusion level. Also, A similar trend was found by Sharif *et al.* (2018), who examined the Effect of adding dried citrus pulp at (10, 20, 30, and 40%) levels in lamb's diet on blood biochemical. They found no significant differences in blood Urea-N and blood glucose in all treatments. Lashkari *et al.* (2017) reported that blood Urea-N was decreased by adding citrus pulp. Sayed and Ghobashy (2018) observed that total protein, total cholesterol, and blood urea were increased ($P < 0.05$). Jingzhi *et al*. (2018) investigated the Effect of supplementation citrus pulp at (0, 7, 14, and 21%) in rabbit ration. Results showed that albumin was decreased ($P < 0.05$), and other blood parameters were not significantly different. Otherwise, Evan *et al*. (2020) demonstrated that the plasma levels of total proteins, amino acids, urea, and hepatic enzymes remained unchanged when cereals and protein concentrates were substituted in a high-cereal concentrate for lambs, which included 18% distiller's dried grains with solubles, 18% dried citrus pulp, and 8% exhausted olive cake as part of the byproduct concentrate. Allam *et al*. (2021) indicated that the blood parameters of experimental cows across all dietary rations remained within the normal limits for alanine transaminase (ALT), aspartate transaminase (AST), total protein (g/dl), albumin (g/dl), creatinine (mg/dl), and urea. Nevertheless, it was observed that both globulin and total lipids experienced a significant reduction ($P \leq 0.05$) as the proportion of dried citrus pulp (DOP) in the diet increased. In recent years, Al-Adawy *et al.* (2024) investigated the impact of using different levels of dried citrus pulp in place of corn at 0%, 30%, and 60% levels on the blood parameters of lactating buffaloes. The study concluded that there were no differences found in the blood parameters assessed.

Generally, the blood characteristics of sheep and calves showed that all biochemical blood parameters were within normal limits. Adding varying amounts of dried orange pulp to the CFM formula instead of yellow corn grains had no discernible impact on the parameters in question and had no negative effects on the kidney or liver.

Blood hematological and immunity parameters

Data in Tables 8, and 9 illustrated that the concentration of hematological blood parameters of the experimental groups did not show significant differences due to feeding the calves and lambs on dried orange pulp. In general, the values of blood hematological parameters were within the normal range; indicating that dried orange pulp substituting for yellow corn at various levels did not negatively impact the animals' health. As shown in Tables 8 and 9, it was observed that no significant effects were reported for all values of immune parameters (IgA, IgG, and IL2), indicating that feeding dried orange pulp did not have any adverse effect on the immune system.

Oni *et al.* (2008) reported that packed cell volume (PCV), hemoglobin concentration (Hb), and red blood cell (RBC) counts were significantly increased ($P < 0.05$) as the proportion of citrus pulp in the diet increased, in

comparison to the control diet. Allam *et al*. (2021) indicated that the blood parameters of experimental cows across all dietary rations remained within the normal limits for platelets, red blood cells (RBCs), hematocrit, and hemoglobin (Hb, g/dl). Nonetheless, a significant reduction (P≤0.05) in white blood cells (WBCs) was observed as the proportion of dried citrus pulp (DOP) in the diet increased. This suggests that DOP can serve as a viable alternative energy source in the diets of Holstein dairy cows, allowing for the replacement of up to 75% of yellow corn grains without negative impact on the animals' health. Rahman *et al*. (2023) showed that CBC and blood biochemicals were not different in goats fed diets containing dried citrus pulp at (0, 10, 15, and 20%) levels.

It could be concluded that all hematological parameters were within the normal values of blood characteristics of calves and sheep. Replacement of yellow corn grains in CFM formula with different dried orange pulp levels had no adverse effect on animal CBC without any adverse effect on animal health.

Table 8: Blood hematology and immunity status of calves as affected by the dietary treatments.

Item	Treatment				*SEM*	*P*-value
	C*	R15	R30	R45		
Hb	12.93	13.20	13.33	13.10	0.09	0.554
RBCs	6.11	6.10	6.20	5.93	0.05	0.229
WBCs	11.16	11.63	11.93	11.96	0.13	0.173
PLT	234.66	232.66	237.00	235.00	0.79	0.308
HCT	18.47	18.20	19.00	19.98	0. 14	0.062
MCV	39.13	38.53	40.00	39.87	0.26	0.143
MCH	20.53	20.63	20.66	20.33	0.07	0.416
MCHC	50.13	45.37	46.57	46.10	0.77	0.105
GRA	2.00	2.30	1.97	2.03	0.06	0.166
LYM	7.46	7.46	7.16	7.56	0.06	0.116
Monocyte	3.00	3.47	3.03	3.67	0.12	0.095
IgA, mg/dl	59.00	60.33	59.00	58.33	0.55	0.688
IgG, mg/dl	159.00	157.67	155.67	157.67	0.51	0.132
Interleukin 2 (Pg/ml)	104.33	98.83	100.13	99.27	1.02	0.212

* Group 1(C) control group, 70% CFM + 20% corn silage + 10% wheat straw. Group 2 (R15): control ration with 15% yellow corn replaced with dried orange pulp. Group3 (R30): control ration with 30% yellow corn replaced with dried orange pulp. Group 4 (R45): control ration with 45% yellow corn replaced with dried orange pulp. Hb: Hemoglobin. RBC: Red blood cells. WBC: White blood cell. PLT: Platelets. MCV: Mean cell volume. MCH: Mean Corpuscular Volume. MCHC: Mean Corpuscular Hemoglobin Concentration. GRA: Granulocytes. LMY: Lymphocytes. IgA: Immunoglobulin A. IgG: Immunoglobulin G. SEM: standard error of means

Table 9: Blood hematology and immunity status of sheep as affected by the dietary treatments.

Item	Treatment				*SEM*	*P*- value
	C*	R15	R30	R45		
Hb	12.00	12.16	12.16	12.00	0.59	0.636
RBCs	4.07	3.85	3.89	4.10	0.06	0.309
WBCs	15.50	13.30	13.23	15.06	0.45	0.154
PLT	588.33[a]	587.33[a]	592.33[a]	555.66[b]	4.84	0.002
MCV	32.43	32.70	33.06	32.56	0.17	0.660
MCH	22.90	24.46	23.73	23.60	0.28	0.276
MCHC	68.53	69.43	68.67	68.73	0.16	0.183
GRA	3.40	3.13	3.13	3.01	0.06	0.182
LYM	10.70	10.50	10.80	10.90	0.06	0.133
Monocyte	3.30	3.36	3.26	3.46	0.34	0.150
IgA, mg/dl	59.33	61.00	60.66	60.33	0.74	0.905
IgG, mg/dl	152.33	147.33	149.33	151.00	0.86	0.193
Interleukin 2 (Pg/ml)	54.33	57.66	55.20	54.53	0.75	0.442

*Group 1(C) control group, 70% CFM + 20% corn silage + 10% wheat straw. Group 2 (R15): control ration with 15% yellow corn replaced with dried orange pulp. Group3 (R30): control ration with 30% yellow corn replaced with dried orange pulp. Group 4 (R45): control ration with 45% yellow corn replaced with dried orange pulp. Hb: Hemoglobin. RBC: Red blood cells. WBC: White blood cell. PLT: Platelets. MCV: Mean cell volume. MCH: Mean Corpuscular Volume. MCHC: Mean Corpuscular Hemoglobin Concentration. GRA: Granulocytes. LMY: Lymphocytes. IgA: Immunoglobulin A. IgG: Immunoglobulin G. SEM: standard error of means

The modulation of the immune system represents a significant health benefit associated with probiotic microorganisms. Research has demonstrated that these probiotics can improve immune responses through the proliferation of T-cells and B-cells, as well as the production of cytokines and immunoglobulins (IgA, IgG). These mechanisms contribute both directly and indirectly to the prevention of various conditions (Kimoto *et al.*, 2007). Otherwise, Allam *et al.* (2021) concluded that DOP can be used as an alternative energy source in Holstein dairy cow's rations, replacing up to 75% of yellow corn grains without showing any harmful effect on animal health. Rahman *et al.* (2023) showed that CBC and blood biochemicals were not different in goats fed diets containing dried citrus pulp at (0, 10, 15, and 20%) levels. In recent years, Al-Adawy *et al.* (2024) examined the impact of replacing corn by dried citrus pulp at (0, 30, and 60%) levels on blood parameters in lactating buffalos. There were non-significant differences found overall the blood parameters evaluated. El-Sheikh *et al.* (2024) investigated the Effect of replacing corn grains with citrus pulp at (0, 25, and 50%) levels. Adding dried citrus pulp to Barki lambs' diets did not affect all blood biochemicals.

Generally, all immunity status values fell within the normal range of sheep and calves' blood characteristics. Replacement of yellow corn grains in CFM formula with different dried orange pulp levels had no adverse effect on animal blood criteria without any adverse effect on animal hygiene and immunity status.

CONCLUSION

Generally, the replacement of yellow corn grains in CFM formula with dried orange pulp in different levels (15, 30, and 45%) had no harmful effect on body weight changes, digestibility, nutritive value, and nitrogen balance. All blood values were within the normal values of blood characteristics of calves and sheep without any adverse effect on liver and kidney functions, animal hygiene, and immunity status. It can be concluded that dry orange pulp can replace up to 45% of yellow corn grains and is more effective

at raising the daily profit percentage in the rations of fattening calves.

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تأثير تغذية تفل البرتقال المجفف على التغيرفى وزن الجسم ومعاملات الهضم وقياسات الدم والحالة المناعية للعجول و الأغنام

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الملخص العربى

تم إجراء الدراسة الحالية في تجربتين منفصلتين؛ أجريت التجربة الأولى لتقييم تأثير استبدال الذرة الصفراء فى مخلوط العلف المركز بتفل البرتقال بمستويات مختلفة (٠ و١٥ و٣٠ و٤٥%) على أداء النمو وكيمياء الدم والحالة المناعية لعجول خليط البراهاما والزيبو (التجربة الأولى)، علاوة على قياس معاملات الهضم والقيمة الغذائية وميزان النيتروجين وتخمرات الكرش وكيمياء الدم والحالة المناعية للأغنام البرقي (التجربة الثانية). تم تغذية الحيوانات في التجربتين على نفس العلائق التجريبية التالية بنظام TMR; العليقة القياسية: C (٧٠٪ مخلوط علف مركز + ٢٠% سيلاج الذرة + ١٠٪ تبن القمح) وR15 (العليقة القياسية مع استبدال ١٥% من الذرة الصفراء بتفل البرتقال المجفف) و R30 (العليقة القياسية مع استبدال ٣٠% من الذرة الصفراء بتفل البرتقال المجفف) و R45 (العليقة القياسية مع استبدال ٤٥% من الذرة الصفراء بتفل البرتقال المجفف). أظهرت النتائج المتحصل عليها أن العجول التى تغذت على العليقة R15 (١٥% تفل برتقال مجفف) سجلت أعلى معدل زيادة وزن كلية وأعلى معدل نمو يومي وكذلك وزن الجسم النهائى حيث كانت القيم 456 كجم و١,٤٩ كجم / يوم و ٨٩,٣ كجم يليها المجموعة القياسية (٤٥٣,٨ و١,٤٦ و٨٧,٨) ومجموعة R30 (٤٤٤,٦ و ١,٤٤ و ٨٦,٣) ومجموعة R45 (٤٤٦,٩ و ١,٤٢ و ٨٥,٤)على التوالي. التغذية على تفل البرتقال المجفف كان أكثر فعالية في زيادة نسبة الربح اليومي حيث بلغت نسبة الربح اليومى ١٩,٤٠ و ٩,٤٢ و ١٥,٢٤% ل R15 و R30 و R45 على التوالي مقارنة بالمجموعة القياسية. إستبدال الذرة الصفراء بمستويات مختلفة من تفل البرتقال المجفف لم يظهر تأثير معنوي على معاملات هضم DM وCP وCF وEE. ومع ذلك زاد معامل هضم NFE معنويا (P = 0.02) مقارنة بالمجموعة القياسية حيث بلغت القيم ٧١,٤٦ و٧٢,١٣ و٧١,٩٨ و٧١,٩٥ بالنسبة لـ C وR15 وR30 وR45 على التوالى ولم تكن الفروق معنوية بين المجموعات المعاملة. قيم ميزان النيتروجين و القيمة الغذائية (DCP وTDN) لم تتأثر معنويا بمستويات إستبدال تفل البرتقال, سجلت جميع قياسات الكرش فروقا معنوية بعد ساعتين من الأكل وأصبحت الفروق غير معنوية عند ٤ ساعات لجميع قياسات الكرش ، حيث انخفضت قيم pH الكرش معنوياً (P=0.045) بعد ساعتين من التغذية بزيادة مستوى تفل البرتقال المجفف حيث بلغت ٦,٣٣، ٦,١٩، ٦,١٦ و٦,١٢ لعلائق المجموعة القياسية و R15 و R30 و R45 على التوالي. الأحماض الدهنية الطيارة بالكرش (TVFA) أيضا سجلت قيما أعلي معنويا (P<0.01) عند ساعتين بعد التغذية لـ R30 وR45 حيث بلغت ١٤,٦٦ و١٤,٨٧ على التوالي مقارنة بعلائق C وR15. سجلت مجموعة R45 قيم أعلى معنويا (P=0.038) لأمونيا الكرش بعد ساعتين من التغذية (١٨,٥٢) مقارنة بمجموعات C وR15 وR30 حيث كانت ١٨,١١ و١٨,٣٠ و١٨,٣٧ على التوالي وكانت الفروق غير معنوية بين R15 وR30 فى حين سجلت هاتين المجموعتين زيادة معنوية مقارنة بالمجموعة القياسية. أظهرت النتائج عدم وجود فروق معنوية بين المجموعات التجريبية في مستويات البروتين الكلي والألبومين والجلوبيولين وAST وALTو اليوريا والكرياتينين في سيرم الدم. التغذية على تفل البرتقال المجفف لم يكن لها أي تأثير سلبى على الحالة المناعية للعجول و الأغنام حيث لم تكن هناك فروق معنوية لقيم المناعة (IgA, IgG, IL2) بين المجموعات التجريبية.

أكدت نتائج الدراسة علي أن تفل البرتقال المجفف ذو فاعلية في زيادة نسبة الربح اليومي في علائق تسمين العجول ويمكن أن تصل نسبة إستبداله إلى ٤٥% من حبوب الذرة الصفراء فى مخلوط العلف المركز.