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EFFECT OF FEEDING GUAVA WASTE ON GROWTH PERFORMANCE, DIET DIGESTIBILITY, CARCASS CHARACTERISTICS AND PRODUCTION PROFITABILITY OF OSSIMI LAMBS.

Tamer M.M. Hassan[1,*]; Fathy A.I. Abdel-Fattah[2]; Ayman S. Farid[3]; and Eman R. Kamel[4]

[1]*Department of Animal Production, Faculty of Agriculture, Benha University, Egypt.*

[2]*Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Benha University, Egypt.*

[3]*Department of Clinical Pathology, Faculty of Veterinary Medicine, Benha University, Egypt.*

[4]*Department of Animal Wealth Development, Faculty of Veterinary Medicine, Benha University, Egypt.*

[*]***Corresponding author:*** tamer.mohamed@fagr.bu.edu.eg.

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SUMMARY

The present study was designed to investigate the effect of including dried guava waste (GW) in diets of Ossimi lambs on growth performance, apparent diet digestibility, carcass characteristics and economic efficiency. Eighteen Ossimi male lambs (average body weight of 28.4±1.7kg) were divided randomly into three experimental groups (6 lambs each). Control group was fed diet based on corn and soybean meal, GW was added as a feed ingredient in the diet at levels of 10% and 20% and fed to other groups (D1 and D2), respectively for 12 weeks. Animals were housed individually in clean and hygienic pens. Body weight was measured weekly and feed consumption was recorded daily. Digestibility trial was conducted and digestion coefficient was calculated for diet dry matter (DM) and nutrients. At the end of study, three animals from each group were slaughtered and carcass traits were evaluated. At the end of experiment, blood samples were collected for analysis and serum biochemistry. Economic feasibility was evaluated for using GW in the diet. Results showed that there were no significant differences between groups in growth performance parameters between groups. Similar findings were recorded for digestibility of DM and nutrients. Addition of 10% and 20% of GW in the diets did not negatively affect blood picture or serum biochemistry and results showed no significant differences in carcass traits and meat analysis. Economical profitability was significantly found when feeding 20% GW in the diet. It can be concluded that GW can be utilized effectively at a level of 20% of the diet without adverse effect on performance, digestibility, carcass traits or health parameters of Ossimi lambs.

Keywords: *Guava waste, sheep, growth performance, economic efficiency, digestion coefficient and carcass.*

INTRODUCTION

In Egypt and many other countries, millions of tons from agro-industrial wastes are produced. When these wastes are accumulated without treatment, they adversely affect the environment. Recently, the growth of animal feed industry has allowed considerable use of agro-industrial by-products that can be properly included in animal feeds. Various agro-industrial wastes and other non-conventional feedstuffs have been evaluated as potential feed ingredients for farm animals (Asmare *et al*., 2010 and Shi *et al*., 2014). The concern for using these alternative feed has increased, especially for reducing the nutritional deficit between animal requirements and feed resource, as the feed costs constitute more than 70% of the total production costs in any livestock enterprise (Al-shanti *et al*., 2013 and Lira *et al*., 2009). The use of plant by-products for animal nutrition is an area of increasing research importance. For the agro-food industry, the use of its co-products in animal feeding represents a mean of nutrient recycling and should be taken into account as a preference way of by-product elimination. Accordingly, the use of agro-industrial wastes can be expected to have a favorable economic effect and a reduction of the environmental encumbrance. Egyptian guava

(*Psidium guaijava* L.) is an important tropical and semitropical, fruits yellow in color and is processed for human nutrition as beverages, puree, jam, canned slices, syrup concentrate and juices.

Guava waste (GW) as one of the agro-industrial by-products contains nutrients in addition to bioactive antioxidant compounds that are capable of preventing the oxidative damage caused by free radicals (Melo *et al*., 2011 and Omena *et al.*, 2012). The seeds, pulp and peels are the main components of the waste product processing industries and they are not yet used for any beneficial purpose. The chemical composition of GW in some literatures revealed that its content of crude protein (CP) was ranged from 8.60 to 10.09%, ether extract (EE) was in the range of 9.69 to 11.68% (Lira *et al*., 2011; El Deek *et al*., 2009a and Santos *et al.*,2009), crude fiber (CF) was between 56.01 and 60.08% (Lira *et al.*,2011). It was found that GW contains high proportion of dietary antioxidant fiber in addition to polyphenolic compounds (El Deek *et al*., 2009a) that provide health benefits for human and animals (Uddin *et al*., 2002). In this trend, GW can be used as feed ingredient for ruminants that able to utilize inexpensive by-products to meet their requirements for maintenance, growth and production (Macias-Cruz *et al*., 2010).

The aim of this study was to evaluate the effect of utilizing dried GW as a feed ingredient in the diet of growing sheep on growth performance, digestibility, carcass characteristics, blood parameters and economic efficiency.

MATERIALS AND METHODS

Experimental design and dietary treatments

Eighteen Ossimi male lambs (mean weight of 28.4±1.7 kg) were obtained from the experimental farm of the Faculty of Agriculture, Moshtohor, Benha University. The animals were randomly divided into three equal experimental groups (*n* = 6). Lambs were housed individually in clean and hygienic pens (0.97m × 2.82m). Lambs were subjected to the routine vaccination program against infectious diseases and also deworming program just before the start of the experiment. At the same time, the experimental animals were sprayed by the suitable pesticides when needed. GW were collected from Vitrac® Company for food processing, Qalyubia, Egypt then dried and crushed in disc crusher, well mixed and stored in a well-ventilated place until utilizing in the diet formulation.

Three experimental diets (Table 1) were formulated according to the nutrient requirements of sheep (NRC, 1985). One basal control and two diets containing 10% (D1) and 20% (D2) of GW were formulated and prepared. After an adaptation period of 7 days, diets were weighed and offered to the animals twice daily at 8:00 am and at 4:00 pm with allowance of 15% refusal in equal quantities for each group. Both of the consumed diets and refusals, if any, were recorded daily. Clean and fresh water with salt lick were also offered *ad libitum*. All lambs were weighed individually every week to the nearest kg in the morning before feeding throughout the experimental period (84 days). Total body weight gain (TBWG), Average daily weight gain (ADWG), total and daily feed intake (TFI, DFI) and feed conversion ratio (FCR) were then calculated.

Digestibility trial

After three weeks preliminary period, a digestibility trial was carried out for determination of the digestion coefficient (DC) of diet dry matter (DM) and nutrients. A stainless steel wire mesh was placed on the floor to keep fecal matter away from urine, which was passed through a stream into drainage. Feed intake was daily recorded. Feces were collected, mixed and weighed at morning for successive 7 days then stored at -20°C till analysis. Fecal samples (10%) were taken daily and dried out at 60°C for 48h and ground. Feed and fecal samples were analyzed according to AOAC (1995). Dry matter was measured using hot air circulation oven (Heraeus Ut20, Germany) at 105 °C for 3 hours. Crude protein was measured using Kjeltec® system 2100, FOSS-Sweden. Ether extract (EE) was determined by Soxtec® system 2045, FOSS-Sweden. Crude fiber (CF) was measured using the method of Van Soest*et al.* (1991) by Fibretherm® system, Gerhardt-Germany. The DC of diet was calculated for DM, CP, EE, CF and nitrogen–free extract (NFE) from each dietary treatment using the equation proposed by McDonald *et al.* (2002).

$$DC\% = \frac{\text{Total amount of nutrients in feed} - \text{total amount of nutrients in feces}}{\text{Total amount of nutrient in feed}} \times 100$$

Table (1). Feed formulation and analysis of complete diets fed to experimental groups.

Feed ingredient	Control	D1	D2
Guava waste (GW)*	00.00	10.00	20.00
Yellow corn	31.10	31.80	32.70
Soybean meal (44%CP)	18.00	15.20	14.00
Wheat bran	05.00	10.80	15.50
Wheat straw	23.20	09.50	00.00
Cottonseed meal	04.00	04.00	04.00
Molasse	05.00	05.00	05.00
Egyptian clover	10.00	10.00	05.00
Sodium bicarbonate	00.50	00.50	00.50
Vitamins and minerals mixture**	00.30	00.30	00.30
Salt	00.70	00.70	00.70
Limestone	01.20	01.40	01.80
Dicalcium phosphate	00.50	00.30	00.00
Ammonium chloride	00.50	00.50	00.50
Total	100.0	100.0	100.0
*Calculated analysis (% on dry matter basis)****			
Metabolizable energy (ME, Mcal/kg)	02.50	02.58	02.66
CP	15.16	15.20	15.15
CF	15.96	16.60	17.60
NDF	32.35	30.38	29.16
ADF	20.67	20.00	19.80
Calcium	00.87	00.88	00.88
Total phosphorus	00.44	00.49	00.50

**GW composition (DM =94.35%; CP = 7.53%; EE = 18.93%; CF = 59.21%; Ash = 1.27%; NFE = 7.41%) according to Kamel et al. (2016).*

ME was estimated according to El-Deek et al. (2009b)

***Purchased by Misr Feed Additives for animal nutrition, Egypt. Each 3 kgcontain: Vitamin A = 12,000,000 IU, D_3 = 2,500,000 IU, E =15,000 mg, Zinc = 60,000 mg, Manganese =70,000 mg, Iron =60,000 mg, Copper =30,000 mg, Iodine =5,000 mg, Selenium = 300 mg, Cobalt = 1000 mg, and Calcium carbonate up to 3 kg.*

****Calculated according to feed composition Table, NRC for sheep (1985).*

Blood picture and chemistry

At the end of experiment, two blood samples were collected from the jugular vein of all animals. One sample was taken on EDTA for hematological parameters, including white blood cells (WBCs), red blood cells (RBCs), hemoglobin (Hb) concentration, packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and percentages of lymphocytes, monocytes and granulocytes using an electronic particle hematology analyzer (HA-22/20/ Vet Clindiag; Clindiag Systems B.V.B.A., Steenberg 66, Pollare/Ninove (9401), Belgium). The second blood sample was collected in plain tubes and centrifuged at 3000 rpm (Sigma 3-18K) for measurement of serum total protein, albumin and globulin according to Belifield and Goldberg (1971), urea and creatinine according to Husdan and Rapaport (1968). Also blood glucose and total cholesterol were measured according to Trinder (1969) and Reschlau et al. (1974).

Carcass characteristics

At the end of experimental period (84 days), three lambs from each group were weighed after 18 hrs fasting and then slaughtered for carcass evaluation (Bellaver *et al.,* 1983). After complete bleeding by hanging the animals in a head down position, carcass was skinned and dressed out. The internal organs were removed from the abdomen and the hot carcass weight was recorded. Dressing percentage was calculated using the following formula:

$$\text{Dressing percentage} = \frac{\text{Hot carcass weight}}{\text{Empty body weight}} \times 100$$

Where, Empty body weight = body weight after complete bleeding and removing of digestive tract.

Weights of heart, spleen, kidneys, liver and testes were recorded to the nearest kilogram.

For each slaughtered lamb, weights of all available prime cuts (round, loin, rack and shoulder) and second cuts (neck, brisket, flank and tail) were measured. Meat section of the rib-eye area (lean and fat) of 9, 10 and 11th rib from each carcass was cut vertically to the vertebral column according to Hankins and Howe (1946). The meat samples of rib-eye area were ground, homogenized and frozen until subsequent analysis. Analysis of moisture, fat, protein and ash in meat was carried out according to AOAC (1995) after thawing for overnight in refrigerator at 4°C.

Economic efficiency measures

The most important economic efficiency parameters investigated in this study are cost parameters, return parameters and net profits. The cost parameters included the total variable cost (TVC), total fixed cost (TFC) and total cost (TC) according to El-Tahaway (2007), Liza (2012) and Omar (2009). The TVC includes the price of the purchased sheep, feed price and GW costs. It was estimated in Egyptian Pound (LE) over the course of experiment. For TFC, the costs of labor, veterinary care (drugs, vaccines and veterinary supervision), water, electricity, in addition to costs of litter and building depreciation were calculated per animal for each group. Hence, all these parameters were considered fixed costs for each animal used in the experiment. The building was depreciated over 25 years and the equipment over 5 years. The TC was computed as the sum of TFC and TVC (Sankhyan, 1983). Total returns (TR) included the values of final body weight, wool and litter sale. Net profit (NP) was calculated by finding the difference between the TR and TC.

Statistical analysis

Shapiro Wilks test was used to examine whether variables were distributed normally. Following data distribution, differences between study groups were analyzed by analysis of variance (ANOVA) and Duncan's multiple comparison Post Hoc tests (Duncan, 1955). Statistical analysis was performed using the statistical software package SPSS for Windows (version 20.0; SPSS Inc., Chicago, IL, USA). Statistical significance between mean values was set at $P<0.05$ and data were reported as means and standard error of mean (SEM).

RESULTS AND DISCUSSION

In the present study, dried GW was used as a low-cost feed ingredient in lamb feeding (10% and 20% of the diet). The main lamb performance parameters, with values of final live-weight, TFI, DFI, TBWG, ADWG, and FCR are summarized in Table (2).

Table (2). Growth performance of growing lambs fed the experimental diets.

Item	Unit	Control	D1	D2	SEM*
Initial weight	kg	28.41	28.58	28.33	1.7
Final weight	kg	48.16	48.50	49.83	2.00
Total feed intake (TFI)	kg	124.13	125.71	125.42	2.14
Daily feed intake (DFI)	kg	1.48	1.50	1.49	0.051
Total body weight gain (TBWG)	kg	19.75	19.58	20.50	0.76
Average daily weight gain (ADWG)	g	235	233	244	9
Feed conversion ratio (FCR)		6.49	6.60	6.12	0.23

**SEM - Standard error of mean*

It was indicated that body weight is generally used to express growth performance of animals (Adeyinka and Mohammed, 2006). Results of the final live body weight, weight gain and FCR showed insignificant improvement ($P>0.05$) for lambs fed diet contained 20% GW. The present results of lambs' performance are similar to those obtained by El-Deek *et al*. (2009a) and Zaminur *et al.* (2013) who used guava by-product in broilers finisher diets and reported that body weight gain, feed intake and FCR in different dietary treatment were almost similar to control group and the differences were not significant. The authors indicated that using GW for feeding broiler chickens at level not more 8% has no adverse effect on performance. Ibrahim *et al.* (2016) found that feeding guava leaves mixed with corn offal improved body weight of West African Dwarf goats. Díaz*et al.* (2013) fed silage made from leaves and pulp residues of guava with whey to beef cattle. It was found that the best growth performance was obtained from feeding silage of guava residues ensiled with whey in comparison with other agro industrial by-products. In a similar feeding trial (Kamel *et al.,* 2016), rabbits fed diet containing 20% GW had growth performance better than the control group.

In laying hens Marquina *et al.* (2008) and El Deek *et al.* (2009b) found that feeding guava by-product (GBP) has improved the performance of egg production. Also, Madhava *et al.* (2004) found that using sun dried guava pomace up to 30% in diets of pigs had not adversely affected the growth performance. Better performance of using GW in the diet is thought to be healthy because of that GW is rich in antioxidant vitamin C (Bikrisima *et al.,* 2014), antioxidant dietary fiber (AODF) with methoxylated pectin (Uddin *et al.*, 2002) and a blend of amino acids, mainly leucine, glutamic acid, arginine, aspartic acid and glycine (Habib, 1986), fatty acids which increase its nutritive value for feeding (Opute, 1978 and Aly, 1981).

The apparent DC% of DM and nutrients of experimental diets are presented in Table (3). Results showed insignificant (P>0.05) difference in DC% of DM, CP, EE, and NFE between different experimental groups. It was observed that CF digestibility decreased significantly (P<0.05) for lambs fed 20% GW in comparison with the control group, while it was insignificantly (P>0.05) decreased when compared with those fed 10% GW. Crude fiber is the portion of diet that is poorly digested in the gut with prolonged retention time inside the rumen (Mertens, 1997). In a digestibility trial in dairy cattle performed by Paengkoum *et al.* (2012), it was found that the rumen degradability of DM and CP of guava leaves was better than that of jack fruit leaves when fed to dairy cattle. They indicated that using guava leaves can be used as alternative feed resource for ruminants. Sahin *et al.* (2002) attributed this positive effect to the antioxidant vitamin C content in GW. Seven, (2008) proposed that vitamin C could hinder the oxidative denaturation of protein, especially under stress.

Table (3). Apparent digestion coefficient (ADC) of diet DM and nutrients in Ossimi male lambs fed on experimental diets.

Item	Treatments			
	Control	D1	D2	SEM [*]
Digestibility %:				
DM	60.50	60.50	60.67	0.41
CP	62.83	62.66	60.50	0.65
CF	57.66^{a}	55.33^{ab}	53.33^{b}	0.88
EE	76.20	76.30	75.53	0.40
NFE	65.63	65.40	65.36	0.32

[*]*SEM - Standard error of mean*

[ab] *within rows means bearing different superscripts differ significantly at P<0.05.*

Braga *et al.* (2016) found that the degradability of guava residues was lowered in sheep gut. This lowered digestibility was attributed to the high amount of seed in the waste with combined large amount of acid detergent fiber (ADF) and lignin. Lignin is indigestible substance that may cover the feed particles in the rumen and prevent the attack of microbial digestive enzymes to the diet resulting in decreased digestibility coefficient (Oliveira *et al.,* 2013).

In other trial in rabbit (kamel *et al.,* 2016), DC% of NDF and ADF were improved for animals fed 20% GW in the diet than that of the control. The results of digestibility in this study were also different from those of Kibria *et al.* (1993) who used guava leaves to evaluate the digestibility coefficient in Black Bengal goats. The authors found that digestibility coefficients were 32.67, 48.62, 57.64 and 33.45% for CP, CF, NFE and EE, respectively. Sharma (1979) indicated that the digestion in goats depended on the nature of the diet, level of feed intake, salivary secretion, manner of rumen fermentation and gut motion. Many factors governing the digestibility of GW, these include the plant varieties, composition and processing methods.

Table (4) shows the results of some biochemical and hematological parameters in the experimental groups. Blood picture and serum biochemistry are important in evaluating the use of non-conventional feed ingredients and their effects on status of animals (Ibrahim *et al.,* 2016). Blood glucose level was found to insignificantly (P>0.05) raised with increasing GW level in the diet. Presence of soluble carbohydrates and digestible nutrients in the diet could increase blood glucose level (Abdollahzadeh *et al.* 2010).Serum levels of proteins and albumin are valuable in reflecting the health of hepatic cells. Serum protein, albumin and globulin values (Table 4) of the control and lambs fed GW did not differ significantly (P>0.05). The values in this study were in the normal range indicating no antinutritional factors that might reduce nutrient absorption in the small intestine, proposing intact hepatocellular functions.

Table (4). Some biochemical and hematological indices of lambs fed the experimental diets

Item	Unit	Control	D1	D2	SEM*
Biochemical parameters					
Glucose	(mg/dl)	117.89	135.20	156. 56	9.94
Total protein	(g/dl)	4.61	5.37	6.07	0.42
Albumin	(g/dl)	3.29	3.56	3.41	0.15
Globulin	(g/dl)	1.32	1.80	2.65	0.34
Total cholesterol	(mg/dl)	85.39	79.03	74.95	2.59
Urea	(mg/dl)	42.03	46.45	49.44	2.73
Creatinine	(mg/dl)	0.72	0.83	0.92	0.05
Hematological parameters					
Red blood cells (RBCs)	(10^6 /µl)	10.96	11.23	10.98	0.21
Hemoglobin(Hb)	(gm/dl)	12.66	13.26	13.00	0.23
PCV	%	49.53	51.36	51.10	1.06
MCV	fl	45.18	45.71	46.54	0.45
MCH	pg	11.54	11.82	11.84	0.10
MCHC	%	25.55	25.86	25.48	0.22
White blood cells (WBCs)	(10^3 /µl)	14.33	13.67	12.00	0.73
Lymphocyte	%	73.46	71.23	73.66	1.75
Monocyte	%	5.26	4.40	5.46	0.56
Granulocyte	%	21.26	24.36	20.86	1.49

**SEM - Standard error of mean.*

PCV: Packed cell volume.

MCV: Mean corpuscular volume.

MCH: Mean corpuscular hemoglobin.

MCHC: Mean corpuscular hemoglobin concentration

Constant serum globulin level can assess animal adaptation to stress and indicates that the lambs were not affected by a disease that would cause an excessive production of antibodies through gamma globulin production (Kaneko *et al.,* 2008). Increasing total proteins and globulin levels with inclusion of GW in the diet might due to its high content of neutral detergent insoluble nitrogen (NDIN), offering available nitrogen for rumen microorganisms and consequently increased protein absorption in the intestine (Braga *et al.,* 2016). Results of this study can be compared favorably with those of (Ibrahim *et al.,* 2016), who found that total protein, albumin and creatinine values of the control and goats fed guava leaf meal were significantly similar. The authors concluded that feeding guava leaf meal up to 10% of the ration had no harmful effect on blood and serum biochemical indices of the goat. Concerning results of total serum cholesterol in the experimental groups fed GW (Table 4), there was an insignificant reduction (P>0.05) in the concentration. It was indicated that the high vitamin C content in GW is responsible for scavenging effect of free radical in the blood, resulting in reducing total cholesterol level (Singh and Rastogi, 1997). The serum urea and creatinine levels were insignificantly (P>0.05) increased with animals fed GW. This higher concentration may be attributed to increased absorption of ruminal ammonia (Abas *et al.,* 2007).

Red blood cells and platelets counts, PCV, Hb, MCV, MCH, and MCHC (Table 4), are indices used for evaluation of bone marrow capacity of blood cells production and diagnosis of anemia (Peters *et al.,* 2012; Etim *et al.,* 2014; Awodie *et al.,* 2005 and Chineke *et al.,* 2006). Hematological results in this study revealed no significant change (P>0.05) between experimental groups. For RBCs count and MCHC, it was no difference between control group and those fed diet with GW and the values were within the normal range. Concerning Hb, PCV, MCV, and MCHC, there was a slight but insignificant (P>0.05) increase in their values when compared with the control. These results were positively comparable to that of Ibrahim *et al.* (2016), who fed guava leaf meal (10% of the ration) to African Dwarf Goats. These blood results indicate a normal healthy condition of the animals (Chineke *et al.,* 2006 and Etim *et al.,* 2010). The normal values of Hb indicated that the diet fed to lambs contained high protein quality (Bello and Tsado, 2014), while the normal PCV values proposed absence of toxic substances such as hemaglutinin which has a bad impact on blood formation (Bello and Tsado, 2013; and Oyawoya and Ogunkunle 1998). As reported previously (Radostits *et al.,* 1994; Adamu *et al.,* 2008 and Etim *et al.,* 2014), hematological values of sheep are significantly affected by nutritional condition. Thus blood results in this study indicate that feeding diet containing GW to lambs were balanced and had no adverse effect on blood and health status. Values of WBC, lymphocytes, monocytes, and granulocytes in this study of lambs fed GW were favorably comparable to control group and within the normal range of Ossimi breed. According to Bello and Tsado (2014), these results pointed out that feeding ration containing GW did not affect the immune system.

Results of carcass characteristics and analysis of rib-eye area (lean and fat) of the experimental lambs are presented in Table (5). Values of carcass traits (hot carcass, dressing percentage, prime and second cuts, and weights of some internal organs) of growing lambs fed GW were statistically similar to the control group.

Table (5). Carcass characteristics and analysis of rib-eye area (lean and fat) of the Ossimi growing lambs fed the experimental diets.

Item	Unit	Control	D1	D2	*SEM*[*]
Hot carcass weight	kg	33.13	29.83	30.33	*1.23*
Dressing percent	%	56.73	55.63	54.46	*0.81*
Prime cuts weight	kg	23.93	20.93	20.63	*0.98*
Second cuts weight	kg	9.15	8.87	9.63	*0.47*
Heart	kg	0.16	0.17	0.16	*0.003*
Kidneys	kg	0.38	0.35	0.28	*0.018*
Liver	kg	0.86	0.83	0.73	*0.043*
Spleen	kg	0.073	0.056	0.057	*0.0036*
Tests	kg	0.42	0.45	0.48	*0.026*
Chemical composition of rib-eye area (lean and fat)					
Moisture	%	69.33	69.66	69.50	*0.20*
CP	%	15.97	16.18	15.94	*0.11*
EE	%	27.28	27.18	26.98	*0.10*
Ash	%	3.03	3.07	3.05	*0.05*

[*]*SEM - Standard error of mean*

These results are favorably compared with those of Silva *et al.* (2014), who found that feeding guava by-product (GBP) to growing sheep at level up to 16.4% of the diet produced carcasses convenient to the consumers, while feeding GBP at level 24.6% of the diet produced carcasses of inferior traits compared to the control. Even in case of feeding sun dried guava pomace up to 30% in the diet of pigs (Madhava *et al.,* 2004), carcass traits were not adversely affected. Similarly, feeding GW to New Zealand rabbits at 20% of the diet resulted in carcass quality parameters not different from the control (Kamel *et al.,* 2016). In other study of feeding the European quail guava residue as a partial substitution of corn in the diet (up to 10%), there were no significant difference between treated and control groups in terms of carcass yield, breast, drumstick, thigh, wings, back, neck, head, feet, heart, liver and gizzard (Camelo *et al.,* 2015).It was concluded that feeding Cobb broiler chicks GW up to 12% (Lira *et al*., 2011) or up to 8% (El Deek *et al.,* 2009a) of the diet revealed no significant difference between groups in carcass traits. Chemical analysis of lamb's meat shows non-significant differences between experimental groups regarding moisture, CP, EE and ash percentages as presented in Table (5). In the study of El-Sayed *et al.* (2013), broiler chicks were fed dried guava leaves as 1% of the diet. The results of meat composition of breast muscle showed increase in DM and decrease in ash and EE contents, while no change in CP level. In another study Abdelhamid and Soliman (2012), the chemical composition of meat from Nile Tilapia fed guava leaves at a level of 1% of the diet revealed significantly higher CP and EE contents and no significant difference in DM and ash percentages.

Economically, TFC (Table 6) included the cost of equipment (8.30 LE), building depreciation (16.60LE), water and electricity (3.30 LE), labor (33.0 LE), and veterinary management (2.70 LE). Therefore, the TFC was 63.9 LE/animal in each group. Concerning the TVC, there were non-significant differences (*P*>0.05) among the experimental groups.

Table (6). Effect of feeding GW to growing lambs on the economic efficiency parameters.

Item (LE/animal)	Control	D1	D2	SEM*
Equipment depreciation	8.30	8.30	8.30	
Building depreciation	16.60	16.60	16.60	
Water and electricity	3.30	3.30	3.30	
Labor	33	33	33	
Veterinary management	2.70	2.70	2.70	
TFC	63.9	63.9	63.9	
Ration cost (L.E/ton)	2088.56	2037.37	1961.43	
Feed cost	518.52^{b}	512.23^{ab}	491.99^{a}	9.12
Purchased sheep	1136.7	1143.3	1133.3	67.9
TVC	1655.19	1655.56	1625.33	76.53
TC	1719.09	1719.46	1689.23	76.54
Sheep sales	1926.7	1926.7	1953.3	84.7
Wool sales	25	25	25	
Litter sales	20	20	20	
TR	1971.7	1971.7	1998.3	84.7
NP	252.58	252.20	309.11	27.2

LE: Egyptian Pound, TFC: Total fixed costs.

TC: Total costs, TVC: Total variable costs.

TR: Total returns, NP: Net profit.

**SEM - Standard error of mean.*

^{ab} *within rows means bearing different superscripts differ significantly at P<0.05.*

The differences in the TVC values were due to the feed cost (cost of total feed intake); it was (LE 518.52) for control group and were (LE 512.23 and 491.99/animal for GW 10% and 20%, respectively). Consequently, the TC values were (LE1719.09; 1719.46 and LE 1689.23/animal) for the control, D1 and D2, respectively. So, the results of TVC and TC indicate that including GW with the percentage of 20% in sheep diet reduced the production cost. Comparatively with the control diet, the results showed that the cost of one ton of feed was reduced for both diet D1 and diet D2.The feed cost/ ton of feed saved about LE 51.19 and LE 127.13/ ton for D1 and D2, respectively; meanwhile, the control diet have the highest cost/ton. Also, the diet D2 containing 20% GW saved LE 75.94 when compared to diet D1 (10% GW).

The obtained TR values (Table 6) including wool and litter sales revealed that were not significantly different (*P*>0.05) among the three experimental groups. Net profit was insignificantly higher (*P*> 0.05) for D2 experimental group (LE 309.11/animal), than that for both the control group and D1 (LE 252.58 /animal and LE 252.20, respectively). Low NP value for D1 was due to relatively higher price of purchasing lambs and higher feed intake which might be due to environmental or genetic individual variations between animals. In this study, it was concluded that diet containing 20% GW can reduce feed costs by about 6% and raise the profits of the total production income by about 22%.

CONCLUSION

Results of this study showed that dried GW can be used satisfactory in sheep diet at level of 20% without any adverse effects the lamb's growth, feed conversion, digestibility, carcass traits and some blood parameters. In case of economic efficiency, addition of GW to the diet reduced the feed costs, which represent a valuable factor in animal production. More studies are required to investigate the effect of including more quantities of GW in the diets of growing sheep and the possibility to add natural feed additives to improve digestibility and feed conversion.

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تـأثير التغذيـة بمخلـف الجوافـة علـى أداء النمـو وهضـم الغـذاء وخصـائص الذبيحـة والكفـاءة الاقتصـادية فـى حمـلان الأوسيمى

تامر مسعد محمد محمد حسن[1] و فتحى عطية اسماعيل عبد الفتاح[2] و أيمن سمير فريد[3] و ايمان رمضان كامل[4]

[1] قسم الانتاج الحيوانى- كلية الزراعة- جامعة بنها- جمهورية مصر العربية

[2] قسم التغذية والتغذية الأكلينيكية- كلية الطب البيطرى - جامعة بنها- جمهورية مصر العربية

[3] قسم الباثولوجيا الأكلينيكية- كلية الطب البيطرى - جامعة بنها- جمهورية مصر العربية

[4] قسم تنمية الثروة الحيوانية- كلية الطب البيطرى - جامعة بنها- جمهورية مصر العربية

تم أجراء هذا البحث لدراسة تأثير اضافة مخلف الجوافة الجافة الى غذاء حملان الأوسيمى مخلف الجوافة الجافة على أداء النمو وهضم الغذاء وخصائص الذبيحة وكذلك الكفاءة الأقتصادية. ثمانية عشر من حملان الأوسيمى الذكور (بمتوسط وزن28.4 كجم) تم تقسيمها عشوائيا الى ثلاث مجموعات اختبارية (ستة حملان بكل مجموعة). كانت مجموعة المقارنة تتغذى على عليقة أساسها الذرة وفول الصويا بينما يضاف مخلف الجوافة على مكونات الغذاء بمستويات 10و20% بالمجموعات الأخرى على الترتيب لمدة 12 أسبوع. تم أيواء الحيوانات بشكل فردى فى حظائر نظيفة وصحية. تم تسجيل وزن الحيوانات أسبوعيا وحساب المأكول اليومى. تم أجراء تجربة الهضم وحساب معامل الهضم لكل من المادة الجافة والعناصر الغذائية. فى نهاية الدراسة تم ذبح 3 حيوانات من كل مجموعة ودراسة صفات الذبيحة عليها. بنهاية التجربة تم أخذ عينات من دم الحيوانات لتحليل صفات الدم. تم تقييم الكفاءة الأقتصادية لأستخدام مخلف الجوافة فى غذاء الأغنام. أظهرت النتائج عدم وجود فروق معنوية بين مجموعات التجربة على أداء النمو. نفس النتائج تم تسجيلها لتقدير معامل الهضم للمادة الجافة والعناصر الغذائية. أظهرت النتائج أن أضافة 10 و20% من مخلف الجوافة لغذاء الحملان لم يؤثرعلى مكونات الدم كذلك صفات الذبيحة وتحليل اللحم. بينما ظهرت اختلافات معنوية بالكفاءة الأقتصادية عند استخدام 20% من مخلف الجوافة فى غذاء الحيوانات.

نخلص من ذلك الى أن مخلف الجوافة يمكن أستخدامه بشكل فعال عند مستوى 20% من النظام الغذائى دون تأثير سلبى على أداء النمو والهضم و صفات الذبيحة أو العلامات الصحية لحملان الأوسيمى.