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Nutritional Impact of Replacement Yellow Corn By Sun Dried Orange Juice Wastes in Sheep Rations on Their Growth Performance, Drinking Water and Economic Efficiency

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Abstract: Animal ration formulation depending on corn grains as a main source of energy, while corn grain is expensive which increase the costs of animal rations. So, it must be search for cheap source of energy to be alternative for grains. Twenty five growing Rahmani male lambs aged 5-6 months with an initial live body weight 23.72±0.111 kg approximately were randomly divided into five experimental groups. Experimental animals were housed in semi-open pens and fed as group feeding for 105 days. Each group lambs received one of the experimental rations that assigned as follows: First[1st] experimental ration contained 40% yellow corn and assigned as control (R_1), second[2nd], third[3th], fourth[4th] and fifth[5th] experimental rations replaced 12.5, 25, 37.5 and 50% of yellow corn in control ration by sun dried orange juice by-products (SDOJBP) for R_2 , R_3, R_4 and R_5, respectively. The important results showed that chemical analysis of yellow corn (YC) supprior in their contents of organic matter (OM), nitrogen free extract (NFE), hemicellulose, cell soluble-NDF, non fiber carbohydrates (NFC), gross energy (GE), digestible energy (DE) total digestible nutrient (TDN) in comparison with sun dried orang juice by-product (SDOJBP). On the other hand, the other determined contents includes crude protein (CP), crude fiber (CF), ether extract (EE), ash neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), cellulose and digestible crude protein (DCP). were supprior for SDOJBP comparing to YC. Experimental rations were almost iso nitrogenous and iso caloric. Crude protein content ranged from 16.86 to 16.90%, meanwhile digestible crude protein (DCP) ranged from 11.83 to 11.87%. Gross energy ranged from 4329 to 4371 kcal/ kg DM, meanwhile total digestible nutrient (TDN) ranged from 74.27 to 74.99% among the five experimental rations. Final weight (FW), total body weight gain (TBWG) and average daily gain (ADG) were significantly ($P<0.05$) improved. Feed intake significantly ($P<0.05$) increased that calculated as dry matter intake (DMI, g/h/day), total digestible nutrients intake (TDNI, g/h/day), digestible crude protein intake (DCPI, g/h/day), gross energy intake (GEI, kcal/h/day), digestible energy intake (DEI, kcal/h/day). Feed conversion were significantly ($P<0.05$) improved. Water intake increased with increasing the level of incorporation SDOJBP in the rations. Daily profit above feeding cost was increased by 6.29; 7.12, 7.38 and 8.06 LE for R_2, R_3; R_4 and R_5, respectively compared to the control R_1 (6.04 LE). Daily feeding cost was decreased, relative economical efficiency was improved by 104.1, 117.9, 122.2 and 133.4 for R_2, R_3; R_4 and R_5, respectively when assuming control ration (R_1) equals 100. Feed cost (LE per kilogram gain) was depressed by 1.68; 10.79; 12.25 and 20.95% for R_2, R_3, R_4 and R_5, respectively, compared to control (R_1). Resulting for by-products from the citrus industry can make an important addition to the amount of locally produced feed for animals. In countries where the quantity of peel and rag from canning industries is large, drying is in most cases the preferred way of conservation because dried citrus pulp is easy to handle, to transport and to mix into compound feeds. So, from the results that illustrated in this study it can be mentioned that sun dried orange juice by-products (SDOJBP) is a good source of energy and can be successfully used as an traditional source for yellow corn in growing lamb rations without causing any deleterious effect on their performance, while realizing a decrease in feed cost with improving economic efficiency, so it can incorporate (SDOJBP) in sheep rations to improve profitability or net revenue and decrease feed cost/ kg gain.

Key words: Orange Juice By-Products · Lambs · Performance · Drinking Water · Economic Efficiency

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INTRODUCTION

As population of human and livestock increasing rapidly, traditional feeding resources for livestock likely to deteriorate in future, this might widen the present gap between nutrient availability and nutrient demand and poses a huge threat to livestock production in Egypt. So, it is important now for livestock production to explore the other alternative ways to feed the animals [1].

Animal ration formulations depending on corn grain as a main sours of energy, while corn grain is very expensive and increase the costs of animal rations. So, it must be search for on a cheap source of energy to use as an alternative for grains. Increased disposal costs in many parts of the world have increased interest in utilization of by-product feedstuffs as alternative feeds for ruminants [2]. Also, they noted that about 24% of world production of citrus is in the Mediterranean countries of Spain, Italy, Greece, Egypt, Turkey and Morocco, with Brazil (24%) and the USA (21%) being major individual citrus producing countries.

The increasing consumption of animal products will give rise to a huge demand of animal feed. Meeting this demand will be a challenge, given the scarcity of natural resources such as land and water. Currently approximately 1.3 billion tones of food is lost and wasted annually and fruit and vegetables form a substantial part of this loss. Use of vegetables waste, as animal feed, can contribute to meeting the feed deficiency existing in most developing countries. Also their use as animal feed will bring them back into the human food chain. Simultaneously it will help mitigating environmental problems that arise due to decomposition of such wastes in the environment [3].

By 2050 the world will need to feed an additional 2.4 billion people and require 60–70% more meat and milk than consumed today; and most of this increase will emanate from developing countries [4-6].

The increasing future demand for livestock products is driven by increase in income, population and urbanization. Livestock is one of the fastest growing agricultural sub sectors in developing countries. This will lead to a huge demand for animal feed. A major constraint to livestock production in developing countries is the lack of good quality feed. Also food security is a major concern in large parts of the developing world. Food-feed-fuel completion as a result of approximately 35 and 5% of cereal production diverted to feed and biofuel production, respectively [7, 8], the combined effects of climate change, land degradation, cropland losses, water scarcity and increase in oil price in the long run, leading to higher cost of inputs such as fertilizers and pesticides are expected to exacerbate the situation.

When orange was processed into juice or sections, 45-60% of their weight remains in the form of peel, rag and seeds. Because of the high water content and perishable nature of the waste, it can only be used economically close to the processing plant. The feed is rather difficult to handle, ferments and sours quickly and can be a fly-breeding nuisance if allowed to spoil [9].

Meanwhile, Crawshaw [10] reported that citrus pulp contains 60-65% peel, 30-35% internal tissues and up to 10% seeds. Due to the high moisture and sugar contents and presence of mould and yeast, citrus pulp gets rapidly deteriorated [11, 12] and may cause environmental pollution.

The reduction and recycling of wastes need urgent attention since it would enhance food security, reduce the environmental footprint of food production chain, decrease waste management costs and open opportunities for production of novel products including animal feed [3].

Citrus fruits contain N (1-2 g/ kg on a wet basis), lipids (oleic, linoleic, linolenic, palmitic, stearic acids, glycerol and a phytosterol), sugars (glucose, fructose, sucrose), acids (primarily citric and malic, but also tartaric, benzoic, oxalic and succinic), insoluble carbohydrates (cellulose, pectin), enzymes (pectinesterase, phosphatase, peroxidase), flavonoids (hesperidin, naringin), bitter principles (limonin, isolimonin), peel oil (d-limonene), volatile constituents (alcohols, aldehydes, ketones, esters, hydrocarbons, acids), pigments (carotenes, xanthophylls), vitamins (ascorbic acid, Vitamin B complex, carotenoids) and minerals (primarily calcium and potassium). These nutrients of citrus by-products is influenced by factors that include the source of the fruit and type of processing [2, 13].

It is noticeable that the price of cereal grains (i.e. yellow corn) is unstable and it keep raising in the local market so, the main objective of this study was designed to formulate a good cheap rations for ruminant animals (sheep) and to establish the impact of replacing yellow corn by sun dried orange juice by-products at different levels on their productive performance, drinking water and economic evaluation.

MATERIALS AND METHODS

This study was carried out in Co-operation work among Animal Production Department, Division of

Agriculture Researches, National Research Center, 33 El-Bohouth Street, P.O: 12622, Dokki, Giza, Egypt and Field Crops Department, Division of Agriculture Researches, National Research Center, 33 El-Bohouth Street, P.O: 12622, Dokki, Giza, Egypt.

This study designed to investigate the influence of partial replacement yellow corn by sun dried orange juice by-products (SDOJBP) in growing sheep rations on their growth performance, drinking water and economic efficiency.

Animals and Feeds: Twenty five growing Rahmani male lambs aged 5-6 months with an initial live body weight 23.72±0.111 kg approximately. The animals were randomly allotted to five experimental groups (five lambs in each treatment). Experimental animals were housed in semi-open pens and fed as group feeding for 105 days, the experimental rations were offered in form of complete feed mixture that formulated to cover the requirements of growing sheep according to the NRC [14]. Lambs were received one of the experimental rations that assigned as follows:

- R_1 : First[1st] experimental ration assigned as control and it contained 40% yellow corn.
- R_2 : Second[2nd] experimental ration replace 12.5% of yellow corn in control ration by sun dried orange juice by-products (SDOJBP).
- R_3 : Third[3th] experimental ration replace 25% of yellow corn in control ration by SDOJBP.
- R_4 : Fourth[4th] experimental ration replace 37.5% of yellow corn in control ration by SDOJBP.
- R_5 : Fifth[5th] experimental ration replace 50% of yellow corn in control ration by SDOJBP.

Daily amounts of the experimental rations were offered at 4% of live body weight and it was adjusted every 2 weeks according to body weight changes. Rations were offered twice daily in two equal portions at 8.00 a.m. and 14.00 p.m. hours, while feed residues were daily collected, sun dried and weekly weighed.

Fresh water was freely available at all times in plastic containers and it was recorded for three times each two week. Individual body weight change was recorded weekly before receiving the morning ration.

Chemical analysis (%) of ingredients presented in Table (1). Meanwhile, the composition and chemical analysis of the experimental rations are illustreated in Table (2).

Analytical Procedures: Chemical analysis of ingredients and experimental ration samples were analyzed according to AOAC [15] methods. Meanwhile, cell wall constituents includes {neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL)} were evaluated according to Goering and Van Soest [16] and Van Soest *et al.* [17]. In addition to, hemicellulose content was calculated as the difference between NDF and ADF, while, cellulose content was calculated as the difference between ADF and ADL.

Calculations: The following calculations were used to evaluate the feed ingredient used in ratiom formulation as follows:

Gross energy (Kcal/ Kg DM) calculated according to Blaxter [18]. Each g CP= 5.65 Kcal, g EE= 9.40 Kcal and g (CF & NFE) = 4.15 Kcal.

Digestible energy (DE) was calculated according to NRC [19] (by applying the following equation: DE (kcal/ kg DM) = GE x 0.76.

Total digestible nutrients (%) was calculated according to NRC [19] where, total digestible nutrients (TDN) % = Digestible energy / 44.3.

Digestible crude protein (%) was calculated according to NRC [19] where, digestible crude protein (%) = 0.85 X1 – 2.5. Where X1= Crude Protein % on DM basis.

Non fibrous carbohydrates (NFC) were calculated according to Calsamiglia *et al.* [20] using the following equation: NFC = 100 – {CP + EE + Ash + NDF}.

Economic Evaluation: Economical efficiency for the tested rations used in this study depended on both local market price of ingredients and price of sheep live body weight. Economic evaluation was calculated as follows:

The cost for 1-kg gain = total cost per Egyptian pound (LE) of feed intake/ total gain (kilogram).

Statistical Analysis: Data collected of live weight, average daily gain feed intake, feed conversion and drinking water were subjected to statistical analysis as one-way analysis of variance according to SPSS [21]. Duncan's Multiple Range Test Duncan [22] was used to separate means when the dietary treatment effect was significant according to the following model:

$Y_{ij} = \mu + T_i + e_{ij}$ Where: Y_{ij} = observation. μ = overall mean. T_i = effect of experimental rations for i = 1-5, 1 = (R_1 contained 40% yellow corn and considered as control), 2 = (R_2 experimental ration replace 12.5% of yellow corn in

control ration by sun dried orange juice by-products (SDOJBP), 3 = (R_3 experimental ration replace 25% of yellow corn in control ration by SDOJBP), 4 = (R_4 experimental ration replace 37.5% of yellow corn in control ration by SDOJBP) and 5 = (R_5 experimental ration replace 50% of yellow corn in control ration by SDOJBP).
e_{ij} = the experimental error.

RESULTS AND DISCUSSION

Data of Table (1) showed that yellow corn (YC) supprior in their contents of organic matter (OM), nitrogen free extract (NFE), cell soluble-NDF, hemicellulose, non fiber carbohydrates (NFC), gross energy (GE), digestible energy (DE) total digestible nutrient (TDN) in comparison with sun dried orang juice by-product (SDOJBP). The corresponding values for these contents were 98.37%, 83.01%, 18.89%, 69.53%, 54.90%, 4423 kcal/ kg DM, 3361 kcal/ kg DM and 75.87% for YC. Meanwhile, the valuse of the same determined contents were 90.40, 64.27%, 16.79%, 64.11%, 38.98%, 4216 kcal/ kg DM, 3204 kcal/ kg DM and 72.33% for SDOJBP. On the other hand, the other determined contents were supprior for SDOJBP comparing to YC. These results mentiond that SDOJBP seemed to be an adaquet or a good source of protein, energy and the other component can be used safely in ration formulation of sheep as alternative or replacement from yellow corn.

Sun dried orang juice by-product (SDOJBP) used in this study was reassonablty comparable in chemical composition to that recorded for citrus pulp by authors world-wide Gad *et al.* [23]; Nouel and Combellas [24]; Aregheore [25]; Chapman *et al.* [26]; Arthington *et al.* [27]; Blezinger [28]; Bueno *et al.* [29]; Peacock and Kirk [30]; Rossi [31]; Villarreal *et al.* [32]; Osman *et al.* [33]; Osman *et al.* [34]; Omer and Tawila [1] and Okoruwa [35]. They reported that citrus pulp contained 90.00 to 94.20% dry matter, 93.7 to 95.00% organic matter, 6.00 to 16.67% crude protein, 12.00 to 17.70% crude fiber, 3.20 to 11.71% ether extract, 3.90 to 7.30% ash; 55.73 to 70.10% nitrogen free extract. In addition to, some variations in the chemical composition of dried citrus pulp can be expected because variation in production site, citrus variety, proportion of seeds & peel and manufacturing processes used [27].

Composition, chemical analysis, cell wall constituents and nutritive values of the different experimental rations are presented in (Table 2). Experimental rations were almost iso nitrogenous and iso caloric. Crude protein content ranged from 16.86 to 16.90%, meanwhile digestible crude protein (DCP) ranged from 11.83 to 11.87%. Gross energy ranged from 4329 to 4371 kcal/ kg DM, meanwhile total digestible nutrient (TDN) ranged from 74.27 to 74.99% among the five experimental rations. On the other hand replacement yellow corn by SDOJBP in the rations occurred an increasing in their content of crude fiber (CF), also it caused a slightly increasing in their contents of cell wall constituents includes (NDF, ADF, ADL, hemicellulose and cellulose), but cell soluble-NDF and non fiber carbohydrates (NFC) were decrease with increasing level of replacement. These results were in agreement with those noticed by Omer and Tawila [1] who fed Baladi goats on rations contained 50% yellow corn (YC) and replace at 12.5 and 50% of YC by dried citrus by-product.

Productive Performance of the Experimental Groups: Data of growth performance is presented in Table (3). Replacing 25, 37.5 and 50% of YC in control by SDOJBP (R_3, R_4 and R_5) occurred a significant ($P<0.05$) increasing in their values of final weight (FW), total body weight gain (TBWG) and average daily gain (ADG). Meanwhile, replacing 12.5 % of YC in control by SDOJBP (R_2) caused in significant ($P>0.05$) increasing in their values of FW, TBWG and ADG. Generally, ADG was gradually increased with increasing the level of replacing YC by SDOJBP. The corresponding value of ADG were 185, 190, 200, 205 and 210 g/day for (R_1, R_2, R_3, R_4 and R_5, respectively. These results in agreement with those noted by Omer and Tawila [1] who mentioned that when Baladi goats fed ration replaced 25 or 50% of yellow corn by citrus by-product (R_2 and R_3) their ADG of Baladi kids insignificantly increased, in addition to ADG improved by 16% and 10% for R_2 and R_3 in comparison with the control one. Rate of weight gain will be directly related to the level of TDN intake [36]. Investigate the impact of replacing maize grain with dried citrus pulp (DCP) in various proportions (20, 40 and 60%) of the diets using local Epirus mountainous breed of sheep on the performance of fattening lambs for 12 weeks was carried out by Koutsotolis and Nikolaou [37]. They noted that DCP can replace maize grain in fattening lambs at a level up to 40% from weaning age (at 42 days) until the age of 126 days without observing significant differences in growth of lambs. In addition, no significant differences in the growth of lambs were recorded with the gradual replacement of maize grain by DCP at different levels used (20, 40 and 60%). Fed lambs on diets containing citrus pulp and wheat straw silage *ad libitum*.

Table 1: Chemical analysis, cell wall constituent and nutritive values of feed ingredients

Item	Feed ingredients				
	YC	SDOJBP	SBM	WB	PVH
Moisture	9.81	10.08	9.63	10.56	10.12
Chemical analysis on DM basis (%)					
Organic matter (OM)	98.37	90.40	93.37	94.88	90.86
Crude Protein (CP)	9.12	9.35	43.52	14.22	14.63
Crude fiber (CF)	2.36	10.60	3.72	8.93	18.16
Ether extract (EE)	3.88	6.18	2.80	3.76	3.92
Nitrogen free extrct (NFE)	83.01	64.27	43.33	67.97	54.15
Ash	1.63	9.60	6.63	5.12	9.14
Cell wall constituents (%)					
Neutral detergent fiber (NDF)	30.47	35.89	31.37	34.79	40.86
Acid detergent fiber (ADF)	11.58	19.10	12.82	17.58	25.99
Acid detergent lignin (ADL)	1.92	3.32	2.15	3.03	4.60
Hemicellulose[1]	18.89	16.79	18.55	17.21	14.87
Cellulose[2]	9.66	15.78	10.67	14.55	21.39
Cell soluble-NDF[3]	69.53	64.11	68.63	65.21	59.14
Non fiber carbohydrates (NFC)[4]	54.90	38.98	15.68	42.11	31.45
Nutritive values					
Gross energy (GE), kcal/ kg DM[5]	4423	4216	4675	43.48	4196
Digestible energy (DE) kcal/ kg DM[6]	3361	3204	3553	33.04	3189
Total digestible nutrient (TDN)[7]	75.87	72.33	80.20	74.58	71.99
Digestible crude protein[8]	5.25	5.45	34.49	9.59	9.94

YC: yellow corn. SDOJBP: sun dried orang by-product. SBM: soybean meal. WB: wheat bran. PVH: peanut vein hay. [1]Hemicellulos = NDF – ADF. [2]Cellulose = ADF – ADL.
[3]Cell soluble-NDF = 100 – NDF. [4]NFC = 100 – {CP + EE + Ash + NDF} according to Calsamiglia et al. [20].
[5]Gross energy (GE): calculated according to Blaxter [18].
[6]Digestible energy (DE): calculated according to NRC [19].
[7]Total digestible nutrient (TDN): calculated according to NRC [19].
[8]Digestible crude protein (DCP): calculated according to NRC [19].

Table 2: Composition and chemical analysis of the different experimental rations

Item	Experimental rations					Price of one kg (LE)
	R_1	R_2	R_3	R_4	R_5	
Replacing level of yellow corn by SDOJBP	0 %	12.5%	25%	37.5%	50%	
Composition (kg/ ton)						
Yellow corn	400	350	300	250	200	3.75
Sun dried orang juice by-product (SDOJBP)	-	50	100	150	200	1.50
Soybean meal	170	170	170	170	170	7.50
Wheat bran	100	100	100	100	100	3.50
Peanut vein hay	300	300	300	300	300	2.00
Lime stone	18	18	18	18	18	0.25
Sodium chloride	7	7	7	7	7	1.00
Anti toxic	1	1	1	1	1	5.00
Vitamin and mineral mixture[1]	4	4	4	4	4	15.00
Price of Ton (LE)	3802	3689	3577	3464	3352	
Chemical analysis (%)						
Moisture	9.75	9.76	9.78	9.79	9.81	
Chemical analysis on DM basis (%)						
Organic matter (OM)	94.68	94.28	93.88	93.48	93.08	
Crude protein (CP)	16.86	16.87	16.89	16.89	16.90	
Crude fiber (CF)	7.91	8.33	8.74	9.15	9.56	
Ether extract (EE)	3.59	3.71	3.82	3.94	4.06	
Nitrogen free extrct (NFE)	66.32	65.37	64.43	63.50	62.56	
Ash	5.32	5.72	6.12	6.52	6.92	
Cell wall constituents (%)						
Neutral detergent fiber (NDF)	33.25	33.53	33.80	34.07	34.34	
Acid detergent fiber (ADF)	16.37	16.75	17.12	17.51	17.88	
Acid detergent lignin (ADL)	2.82	2.89	2.96	3.03	3.09	
Hemicellulose[2]	16.88	16.78	16.68	16.56	16.46	
Cellulose[3]	13.55	13.86	14.16	14.48	14.79	
Cell soluble-NDF[4]	66.75	66.47	66.20	65.93	65.66	
Non fiber carbohydrates (NFC)[5]	40.98	40.17	39.37	38.58	37.78	
Nutritive values						
Gross energy (GE), kcal/ kg DM[6]	4371	4360	4350	4340	4329	
Digestible energy (DE) kcal/ kg DM[7]	3322	3314	3306	3298	3290	
Total digestible nutrient (TDN)[8]	74.99	74.81	74.63	74.45	74.27	
Digestible crude protein[9]	11.83	11.84	11.86	11.86	11.87	

[1]Vitamin & Mineral mixture: Each kilogram of Vit. & Min. mixture contains: 2000.000 IU Vit. A, 150.000 IU Vita. D, 8.33 g Vit. E, 0.33 g Vit. K, 0.33 g Vit. B_1, 1.0 g Vit. B_2, 0.33g Vit. B_6, 8.33 g Vit.B_5, 1.7 mg Vit. $B1_2$, 3.33 g Pantothenic acid, 33 mg Biotin, 0.83g Folic acid, 200 g Choline chloride, 11.7 g Zn, 12.5 g Fe, 16.6 mg Se, 16.6 mg Co, 66.7 g Mg and 5 g Mn.
[2]Hemicellulos = NDF – ADF. [3]Cellulose = ADF – ADL. [4]Cell soluble-NDF = 100 – NDF.
[5]NFC = 100 – {CP + EE + Ash + NDF} according to Calsamiglia et al. (1995).
[6]Gross energy (GE): calculated according to Blaxter (1968).
[7]Digestible energy (DE): calculated according to NRC (1977).
[8]Total digestible nutrient (TDN): calculated according to NRC (1977).
[9]Digestible crude protein (DCP): calculated according to NRC (1977).
R_1: first[1st] experimental ration assigned as control and it contained 40% yellow corn.
R_2: second[2nd] experimental ration replace 12.5% of yellow corn in control ration by SDOJBP.
R_3: third[3th] experimental ration replace 25% of yellow corn in control ration by SDOJBP.
R_4: fourth[4th] experimental ration replace 37.5% of yellow corn in control ration by SDOJBP.
R_5: fifth[5th] experimental ration replace 50% of yellow corn in control ration by SDOJBP.

Table 3: Productive performance and drinking water of the experimental groups

Item	Experimental rations R_1	R_2	R_3	R_4	R_5	SEM
Replacing level of yellow corn by SDOJBP	0 %	12.5%	25%	37.5%	50%	
Live body weight						
Lambs number	5	5	5	5	5	-
Initial weight (kg)	23.100	24.000	23.600	24.100	23.800	0.11
Final weight (FW, kg)	42.500^{c}	43.950^{bc}	44.600^{ab}	45.600^{ab}	45.800^{a}	0.37
Total body weight gain (TBWG, kg)	19.400^{c}	19.950^{bc}	21.000^{ab}	21.500^{a}	22.000^{a}	0.31
Experimental duration period	105 days					
Average daily gain (ADG, g/day)	185^{c}	190^{bc}	200^{ab}	205^{a}	210^{a}	2.93
Average body weight, kg*	32.800^{b}	33.975^{a}	34.100^{a}	34.850^{a}	34.800^{a}	0.23
Metabolic body weight ($kgW^{0.75}$)	13.71^{b}	14.07^{a}	14.11^{a}	14.34^{a}	14.33^{a}	0.07
Feed intake						
Dry matter intake (DMI) as						
g/h/day	1200^{d}	1251^{b}	1230^{c}	1280^{a}	1220^{c}	7.70
$g/kgW^{0.75}$	87.53^{bc}	88.91^{ab}	87.17^{c}	89.26^{a}	85.14^{d}	0.73
Total digestible nutrients intake (TDNI) as						
g/h/day	900^{c}	936^{b}	918^{b}	953^{a}	906^{b}	7.55
$g/kgW^{0.75}$	65.65^{a}	62.53^{b}	65.06^{a}	66.04^{a}	63.01^{b}	0.35
Digestible crude protein intake (DCPI) as						
g/h/day	142^{c}	148^{b}	146^{b}	152^{a}	149^{b}	1.22
$g/kgW^{0.75}$	10.36^{b}	10.52^{a}	10.35^{b}	10.60^{a}	10.40^{c}	0.07
Gross energy intake (GEI) as						
kcal/h/day	5245^{d}	5454^{b}	5351^{c}	5555^{a}	5281^{cd}	32.19
$kcal/kgW^{0.75}$	383^{ab}	388^{a}	379^{b}	387^{a}	369^{c}	2.01
Digestible energy intake (DEI) as						
kcal/h/day	3986^{d}	4146^{b}	4066^{c}	4221^{a}	4014^{cd}	24.48
$kcal/kgW^{0.75}$	291^{ab}	295^{a}	288^{b}	294^{a}	280^{c}	1.57
Feed conversion expressed as g. intake / g. gain of						
Dry matter	6.49^{c}	6.58^{c}	6.15^{b}	6.24^{b}	5.81^{a}	0.074
Total digestible nutrients	4.86^{c}	4.93^{d}	4.59^{b}	4.65^{c}	4.31^{a}	0.045
Digestible crude protein	0.77^{c}	0.78^{c}	0.73^{b}	0.74^{b}	0.71^{a}	0.001
Feed conversion expressed as kcal intake / g. gain of						
Gross energy	28.35^{c}	28.71^{c}	26.76^{b}	27.10^{b}	25.15^{a}	0.34
Digestible energy	21.55^{c}	21.82^{c}	20.33^{b}	20.59^{b}	19.11^{a}	0.26
Drinking water						
ml/h/day	3750^{c}	3820^{c}	3890^{bc}	4050^{ab}	4150^{a}	44.42
$ml/ kgw^{0.75}$	274^{b}	271^{b}	276^{ab}	282^{ab}	290^{a}	2.50
Liter/ kg dry matter intake	3.125^{b}	3.054^{c}	3.163^{b}	3.164^{b}	3.402^{a}	0.04
Liter/ kg total digestible nutrients intake	4.167^{c}	4.081^{d}	4.237^{b}	4.250^{b}	4.581^{a}	0.05
Liter/ kg digestible crude protein intake	26.41^{b}	25.81^{b}	26.64^{b}	26.64^{b}	27.85^{a}	0.30
Liter/ M cal gross energy intake	0.715^{b}	0.700^{b}	0.727^{b}	0.729^{b}	0.786^{a}	0.011
Liter/ M cal digestible energy intake	0.941^{b}	0.921^{b}	0.957^{b}	0.959^{b}	1.034^{a}	0.013

a, b c and d: Means in the same row having different superscripts differ significantly ($P<0.05$).

SEM: Standard error of mean. * Average body weight, kg = initial weight + final weight/ 2.

SDOJBP: Sun dried orang juice by-product.

R_1: first^{1st} experimental ration assigned as control and it contained 40% yellow corn.

R_2: second^{2nd} experimental ration replace 12.5% of yellow corn in control ration by SDOJBP.

R_3: third^{3th} experimental ration replace 25% of yellow corn in control ration by SDOJBP.

R_4: fourth^{4th} experimental ration replace 37.5% of yellow corn in control ration by SDOJBP.

R_5: fifth^{5th} experimental ration replace 50% of yellow corn in control ration by SDOJBP.

No differences were observed for live weight between treatments as described by [38]. Also, use of carob pulp and orange pulp in replacement of cereal grains in lamb fattening diets based on faba bean did not affect final live weight, average daily weight gain [39]. In addition to, Peacock and Kirk [30] noted that there were no significant differences in gain for steers fed citrus pulp, corn feed meal and ground snapped corn when combined with adequate protein and other essential nutrients in a ration for young growing steers. Also, Lanza [40] reported that half substitution of corn grain by dried orange pulp concentrates fed to Friesian heifers, from 6 to 18 month, did not negatively affect body weight. On the other hand, Jingzhi *et al.* [41] noted that incorporation dietary citrus pulp in rabbit rations 0 (control group), 7%, 14% and 21% did not affect the daily feed intake, average daily gain and feed conversion ratio.

Dietary treatments significantly (P<0.05) increased the feed intake that calculated as dry matter intake (DMI, g/h/day), total digestible nutrients intake (TDNI, g/h/day), digestible crude protein intake (DCPI, g/h/day), gross energy intake (GIE, kcal/h/day), digestible energy intake (DEI, kcal/h/day). These results in disagreement with those obtained by Omer and Tawila [1] who showed that when Baladi goats fed ration replaced 25 or 50% of yellow corn by citrus by-product had no significant (P>0.05) effect on feed intake that calculated as DMI, TDNI, crude protein intake (CPI) and DCPI. These indicate that, the sun dried citrus by product (SDCBP) had no adverse effect on palatability. Also, Lanza [40] noted that, when partial or total substitution of corn or barley grain by dried orange pulp (DOP) or dried lemon pulp (DLP) in the concentrates fed to Friesian dairy cattle was not effect on their feed intake. Replacement of cereal grains by orange pulp in lamb fattening diets based on faba bean did not affect dry matter intake [39]. In addition to, Bueno *et al.* [29] noted that when Saanen kid received rations replaced corn with dehydrated citrus pulp (DCP) at levels 0, 33, 66 and 100% feed intake showed a quadratic effect (P<0.05) with the increasing levels of replacement.

Feed conversion that expressed as g. intake/ g. gain of dry matter, total digestible nutrients and digestible crude protein or that expressed as kcal intake/ g. gain of gross energy and digestible energy were significantly (P<0.05) improved when sheep fed rations replaced yellow corn in control by SDOJBP. The best feed conversion was recorded with sheep fed ration replaced 50% of yellow corn by SDOJBP (R_5). These results in agreement with those found by Omer and Tawila [1] who showed that when Baladi kids fed ration replaced 25 of yellow corn by citrus by-product caused an improving in their feed efficiency (g. gain/ g. intake) reach to 16% comparing to control one. Meanwhile, Pascual and Carmona [42, 43] fed growing lambs at an average weight of 15 Kg on diets containing 0, 15, 30, 45 and 60% citrus pulp in the concentrate and 10-15% alfalfa hay, they noticed that feed efficiency were not altered significantly up to 30% incorporation of citrus pulp, but if higher quantities were added the animal response was poorer. No differences occurred between treatments in feed conversion ratio when replacing corn grain with dried citrus pulp in diets containing various concentrate levels and fed to bulls [44]. On the other hand, Bueno *et al.* [29] investigated the impact of replacing corn with dehydrated citrus pulp (DCP) in growing Saanen kid diets at levels 0, 33, 66 and 100%, they mentioned that feed conversion showed a quadratic effect (P<0.05) with the increasing levels of replacement.

Drinking Water by the Experimental Groups: In general noticed that with increasing the level of replacement of yellow corn by SDOJBP the quantity of water intake was increased. In adition to, R_4 and R_5 that replaced 37.5 or 50% of yellow corn in control group (R_1) by SDOJBP caused significantly (P<0.05) increasing in their drinking water, meanwhile, sheep that fed (R_2 and R_3) that replaced 12.5 or 25% of yellow corn realized in significantly (P>0.05) increasing in drinking water consumption. The highest value of drinking water that calculated as (ml/h/day, ml/kgw$^{0.75}$, liter/ kg dry matter intake, liter/ kg total digestible nutrients intake, liter/ kg digestible crude protein intake, liter/ M cal gross energy intake and liter/ M cal digestible energy intake) were recorded when sheep fed ration replaced 50% of yellow corn by SDOJBP (Table 3). These results were disagreement with those obtained by Omer and Tawila [1] who reported that when Baladi goats fed ration replaced 25 or 50% of yellow corn by citrus by-product insignificant (P>0.05) decreased their quantities of water intake. The daily water requirement of livestock varies significantly among animal species. The animal's size and growth stage will have a strong influence on daily water intake. Consumption rates can be affected by environmental and management factors. Air temperature, relative humidity and the level of animal exertion or production level are examples of these factors. The quality of the water, which includes temperature,

Table 4: Economic evaluation of the experimental groups

Item	Experimental rations R_1	R_2	R_3	R_4	R_5
Replacing level of yellow corn by SDOJBP	0 %	12.5%	25%	37.5%	50%
Daily feed intake (fresh, kg)	1.330	1.386	1.363	1.419	1.353
Value of 1-kg feed (LE)	3.802	3.689	3.577	3.464	3.352
Daily feeding cost (LE) [a]	5.06	5.11	4.88	4.92	4.54
Average daily gain (kg)	0.185	0.190	0.200	0.205	0.210
Value of daily gain (LE) [b]	11.10	11.40	12.00	12.30	12.60
Daily profit above feeding cost (LE)	6.04	6.29	7.12	7.38	8.06
Relative economical efficiency [c]	100	104.1	117.9	122.2	133.4
Feed cost (LE/ kg gain)	27.35	26.89	24.40	24.00	21.62

LE = Egyptian pound equals 0.06 American dollars ($) approximately.

a: based on price of 2020.

b: Value of 1-kg live body weight equals 60 LE (2020).

C: Assuming that the relative economic efficiency of control ration (R_1) equals 100.

R_1: first[1st] experimental ration assigned as control and it contained 40% yellow corn.

R_2: second[2nd] experimental ration replace 12.5% of yellow corn in control ration by SDOJBP.

R_3: third[3th] experimental ration replace 25% of yellow corn in control ration by SDOJBP.

R_4: fourth[4th] experimental ration replace 37.5% of yellow corn in control ration by SDOJBP.

R_5: fifth[5th] experimental ration replace 50% of yellow corn in control ration by SDOJBP.

salinity and impurities affecting taste and odour, will also have an effect. The water content of the animal's diet will influence its drinking habits. Feed with a relatively high moisture content decreases the quantity of drinking water required as noted by Ward and McKague [45]. Also, they noted that providing enough quality water is essential for good livestock husbandry. Water makes up 80% of the blood, regulates body temperature and is vital for organ functions such as digestion, waste removal and the absorption of nutrients. Understanding daily livestock watering needs is key when designing a livestock watering system.

Economic Evaluation of the Experimental Groups: Economic efficiency was represented by daily profit over feed cost. The costs were based on average values of year 2020 for feeds and live body weight. Feeding costs and profit above feeding costs are shown in Table (4). Data obtained cleared that with increasing the level of replacing yellow corn by SDOJBP in lamb fed rations occurred an increasing in their daily profit above feeding cost by 6.29; 7.12, 7.38 and 8.06 LE for R_2, R_3; R_4 and R_5, respectively in comparison with the control R_1 that recorded 6.04 LE as a result of increasing ADG with decreasing in daily feeding cost from 5.06 LE in (R_1) to 5.11, 4.88, 4.92 and 4.54 LE in R_2, R_3, R_4 and R_5 respectively. On the other hand, relative economical efficiency was improved by 104.1, 117.9, 122.2 and 133.4 for R_2, R_3; R_4 and R_5, respectively when assuming that the relative economic efficiency of control ration (R_1) equals 100. Meanwhile, feed cost (LE per kilogram gain) was depressed by 1.68; 10.79; 12.25 and 20.95% for R_2, R_3, R_4 and R_5, respectively, compared to control (R_1). These results in agreement with those obtained by Omer and Tawila [1] who noted that when Baladi goats fed control ration contained 50% yellow corn (R_1), meanwhile R_2 and R_3 replaced 12.5% or 50% of yellow corn in control ration by citrus by-product caused decreasing in total daily feeding costs of the tested rations by 9.26% and 19.44% for R_2 and R_3, respectively. Also, they reported that, feed cost LE/ kg gain were improved by 21.76 and 26.76% for R_2 and R_3, respectively compared to the control (R_1).

CONCLUSION

From the result illustrated in this study, it can be mentioned that sun dried orange juice by-products can be a successful using as alternative source of energy for yellow corn that considered the main source of energy in animal ration formulation without occurring any deleterious effect, in addition to decreased the rations costing with realize an improving in their productive performance and economic efficiency.

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