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Effect of processing orange pulp with *Saccharomyces cerevisiae* yeast on growth performance, nutrients digestibility and blood parameters of Barki lambs.

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ABSTRACT

The objective of the present study was to evaluate the effect of replacing concentrate feed (CFM) mixture with different levels of treated orange pulp (TOP) on growth performance, rumen fermentation, nutrients digestibility and blood parameters of growing lambs. Eighteen Barki lambs in three similar groups fed concentrate feed mixture and berseem hay at rate 60:40. Citrus pulp replaced CFM in rations T1, T2 and T3 at rates 0, 20 and 40 %, respectively. Feeding trial lasted 90 days. Average daily gain (ADG) showed a significant increase with increasing levels of replacement. Inclusion of 20 and 40% of TOP in the diet increased dry matter intake (DMI) compared to the control group. Ruminal ammonia-N concentration showed a linear decrease. Ruminal fluid pH not affect with increasing replacement of CFM by TOP. Acetate concentration showed a linear increase. On the other hand, blood total protein and cholesterol showed linear increase. Organic matter, crude protein and neutral detergent fiber showed a quadratic effect with the level of replacement. The results showed that using treated orange pulp (TOP) at rates 20 or 40% instead of CFM had better daily gain, more feed efficiency and lowest cost with the highest economic efficiency. The results of the present study show that replacement of CFM by TOP improved and enhanced ADG for replacement level 40%. Meanwhile, no adverse effects noticed on growth performance, rumen fermentation, nutrients digestibility and blood parameters.

INTRODUCTION

Citrus fruit product is one of the most abundant fruit crops among the world. Citrus fruit peels, a by-product of the citrus industry, represent about 65% of the total weight of the processed fruits. Dried citrus waste (pulp) is usually a valuable feed commodity. Its energy value is high and used extensively in rations of dairy cattle as it have a fairly high protein content (4 – 7%), however, micro-fungi solid substrate fermentation of this pulp could increase protein content, antioxidant activity and digestibility of the pulp (Oboh and Akindahunsi, 2003; Oboh 2006).

Dried citrus pulp contains various soluble and non-soluble carbohydrate polymers that make it an ideal animal feed**.** Citrus pulp is a valuable edible material that includes a wide range of energy sources for rumen microorganisms (Miron et al., 2002, Scerra et al., 2001 and Tripodo et al., 2004). Every year large amount of fresh citrus pulp added to the diet of ruminants. Wet citrus pulp processing for increasing the protein content will cause increase its efficiency in animal feeding. Research results indicate that processed citrus pulp, by using the fungus, increased crude protein. Fungi convert fermentable and lignocellulose materials in the pulp into energy, protein and carbon dioxide by extracellular enzymes (Scerra et al., 1999). Citrus pulp is suitable source of soluble carbohydrate and NDF (Miron et al., 2002), these carbohydrates are energy sources that are available for rumen microorganisms.

Fermentation is one of the oldest applied biotechnologies, have been used in food processing and preservation as well as beverages production for over 6000 years ago (Motarjemi, 2002; Oboh 2006). Fermentation enhances the nutrients content of foods through biosynthesis of vitamins, essential amino acids and proteins, which improve protein quality and fiber digestibility. It also enhances micronutrient bioavailability and aids in degrading anti-nutritional factors (Oboh and Akindahunsi, 2003; Oboh et al 2003; Oboh 2006). It also enhances the medicinal potentials of fermented foods through the proliferation of microorganism (single cell protein), secretion of extracellular enzymes; breakdown of food macromolecules by microbial enzymes to produce bioactive substances such as free soluble phenols and bioactive peptides with antioxidant activity that responsible of its nutraceutical effects (Oboh et al 2008; Oboh et al., 2009). This study therefore sought to integrate citrus peels into useful nutritional and nutraceutical use through Saccharomyces cerevisae solid substrate fermentation techniques.

The process of protein enrichment using the microorganisms in a semisolid culture to improve the nutritional value of the forage palm for ruminants feeding has been evaluated (Araujo et al., 2008; Vendruscolo et al., 2009). Fermentation of cassava peels by pure culture of *S. cerevisiae* could increase its protein content from 2.4% in non-fermented cassava to 14.1% in fermented products (Antai & Mbongo, 1994). The fermented cassava flour with *S. cerevisiae* enhanced the protein level (from 4.4% to 10.9%) and decreased the amount of cyanide content (Oboh & Kindahunsi, 2003). The use of by-products from agricultural and food factories in animal nutrition refers to the time of domestication of livestock. Effective utilization of agricultural by-products as animal feed depends on factors such as nutrient composition of the by-products compared with animal requirements (McDonald et al., 2011). Citrus pulp is a valuable feedstuff containing a variety of energy substrates for ruminal micro-organisms (Scerra et al., 2001; Miron et al., 2002; Tripodo et al., 2004). Processing wet citrus pulp for improving protein content increases their efficiency for livestock feeding. Some studies showed that processing citrus pulp with fungi increased the crude protein because fungi convert lignocelluloses and easily-digestible materials to energy, protein and CO_2 by extracellular enzymes (Scerra et al., 1999). The physical characteristics of feedstuffs for ruminants have been rarely measured; particularly those define nutritional values used in ration formulation. Citrus pulp is a source of soluble carbohydrates and neutral detergent fiber (NDF) (Miron et al., 2002). In fact, citrus pulp is an energy source for rumen micro-organisms.

The objective of this study was to evaluate the effect of replacing citrus pulp processed with *Saccharomyces cerevisiae* to CFM on chemical composition, digestion coefficients ,blood parameters and performance of Barki lambs.

MATERIAL AND METHODS

This experiment carried out at Borg Elarb, Animal Production Research Station of Animal Production Research Institute, Agriculture Research Center during summer season of (2017).

Preparing orange citrus pulp

Samples of orange citrus pulp collected and treated with *Saccharomyces cerevisiae*, dried and then examined to define the chemical composition. The temperature, humidity and acidity of citrus pulp adjusted to fit optimal conditions for growth. After being dried, the pulp was mixed by water at rate of 1:2 (pulp: water) to supply *S. cerevisiae* with relative humidity of 85%. The measured pH was 3.6. The optimum pH for yeast activity is between 5 and 6 according to Dadvar *et al.* (2015). Therefore, 6.4% bicarbonate added to citrus pulp to increase the pH. The orange citrus pulp samples placed in 35 °C incubator in which yeast could grow. In order to achieve high level of crude protein, a pre-test carried out to determine the optimum processing time and required level of yeast. Also, different times of processing and levels of yeast were examined. The results presented in Table 1. According to these results, it decided to use 4% yeast and 24 h processing time in this experiment. After processing, the samples placed in oven, and their dry matter was determined.

Chemical analysis:

Feed ingredients, *S. cerevisiae* powder, concentrate feed mixture (CFM), berseem hay (BH) and feces were analyzed for proximate analysis according to AOAC (1995) whereas, nitrogen free extract (NFE) was calculated by difference. Fiber fractions (NDF and ADF) analyzed according to (Van Soest, 1991).

Table (1): Chemical composition of untreated orange pulp (UOP) and treated orange pulp (TOP) (on DM basis%).

Items (%)	DM	OM	CF	CP	EE	NFE	ASH	NDF	ADF	ME
UOP	88.89^{a}	90.22^{a}	15.86^{a}	8.80^{b}	3.03	62.53^{a}	9.78^{b}	26.1^{a}	23.30^{a}	3.15^{a}
TOP	84.67^{b}	88.90^{b}	12.81^{b}	13.61^{a}	3.21	59.27^{b}	11.10^{a}	18.5^{b}	15.00^{b}	2.85^{b}
± SE	0.55	0.85	1.15	0.06	0.86	0.60	1.17	1.90	0.21	0.16

a,b : Means of different superscripts in the same row are significant ($P<0.05$) different.
Metabolisable energy (Mcal/kg DM) = 10 [(3.5 crude protein) + (8.5 crude fat) + (3.5 Nitrogen-free extract)].According to Natalie et al (2017)

Experimental rations and animals:

Experimental rations consisted of concentrate feed mixture (CFM) and berseem hay (BH) ae rate 60:40. The first group (control) received the basic experimental ration, the 2nd and 3rd groups received experimental ration with replace of 20 & 40% of CFM by treated orange citrus pulp. Chemical composition of raw materials and different experimental rations presented in Table (1 and 2).

Digestibility trials:-

Three digestibility trials were conducted using 3 animals from each feeding treatment using acid insoluble ash (AIA) technique as internal marker according to Van- Keulen and young (1977) to determine the digestibility and feeding values of the experimental rations. Fecal grab samples of nearly 100 g taken from the rectum twice daily at 8 am and 6 pm for 3 days collection period. Representative samples of feed and feces

Table (2): Chemical composition of CFM, BH, treated orange pulp (TCP) and experimental rations (on D M basis%).

	Chemical composition (%)								
Items	DM(%)	OM	CF	CP	EE	NFE	NDF	ADF	ASH
BH	89.93	87.98	25.65	12.80	2.23	47.30	49.20	34.13	12.02
CFM	91.53	90.67	11.12	13.85	2.82	62.88	35.67	23.10	9.33
TOP	84.67	88.90	12.81	13.61	3.21	59.27	18.5	15.00	11.55
Chemical composition of experimental rations									
T1	90.89	89.59	16.93	13.43	2.58	56.65	41.08	27.51	10.41
T2	90.07	89.59	17.14	13.40	2.58	56.47	37.65	25.89	10.41
T3	89.24	89.17	17.34	13.37	2.67	55.79	34.21	24.27	10.83

* T1: control ration (60% CFM + 40% BH), T2:40% CFM + 40% BH+ 20%TOP, T3:20% CFM + 40% BH+ 40%TOP.

of the whole collection period were prepared for proximately analysis according to A.O.A.C. (1995). The concentrate feed mixture consisted of 35% decorticated cotton seed cake, 25% corn grain, 30% wheat bran, 5% molasses, 2% limestone, 1.5% salt and mineral and 1.5% vitamins mixture.

Rumen liquor:

Ruminal fluid samples were collected at the end of the experiment using stomach tube before feeding then at 3 and 6 hrs. after feeding. Samples of rumen liquor, for each animal, filtered through four layers of cheesecloth, then ruminal pH was immediately recorded using digital pH meter then, samples were stored at -20 ºC for latter analyses. Ruminal ammonia nitrogen (NH3-N) concentration was determined according to Conway (1957). Ruminal total volatile fatty acids (TVFA's) concentration was determined according to Warner (1964).

The microbial protein synthesis (g MP/day) in the rumen of sheep fed the experimental diets calculated using the model equation of Borhami et al. (1992) as follow:

g MP/day = mole VFA produced / day X 2 X 13.48 X 10.5 X 6.25 / 100

where one mole VFA yield about 2 mole ATP (Walker, 1965), one mole ATP produce 13.48 YATP (g DM microbial cell) Borhami *et al.* (1979), N % of dry microbial cell = 10.5 (Hungate, 1965).

Feedlot performance:

Eighteen Barki lambs averaged 18 kg body weight and 4 months old divided into 3 groups each of 6 animals according to live weight for 90 days trial. Animals weighed individually biweekly until end of the experiment. The growing goats fed (in groups) CFM and BH. Orange pulp used at rates 20 and 40 % instead of CFM in 2nd and 3rd experimental group, respectively. Feed offered twice a day at 8 am and 4 pm and the remaining amounts from the previous day were measured. Water offered freely all the day round. The CFM adjusted biweekly according to the body weight changes. Daily feed intake, daily body weight gain were recorded and feed efficiency (g feed/g gain) were calculated . Lambs weighed biweekly before morning feeding after 17 hours fasting period. Experimental rations were offered as 60 % CFM and 40% berseem hay) which offered at 3% of live body weight (LBW).

Blood collection and analyses:

The blood samples taken at the end of the experiment from the jugular vein in dry clean glasses tubes. Blood samples collected into sterile blood tubes and immediately placed in ice before centrifuging to obtain serum. The serum immediately frozen for subsequent biochemical analysis. Blood parameters, including glucose, total protein, urea-N, total triglycerides, total cholesterol, high-density lipoprotein and low density lipoprotein, were measured using enzymatic procedures and commercial kits.

Statistical analysis:

Analysis of variance (one-way, ANOVA) was performed to compare between different groups. Statistical analysis was carried out using SAS (2001) and Duncan’s multiple range Test (Duncan, 1955) which used to separate the means when the main effect was significant.). The used model was:

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

Where: Y_{ij} = Individual observation, μ = overall mean, T_i = effect of treatment, e_{ij} = random error

RESULTS AND DISCUSSION

Data presented in table (1) show that treating orange pulp (TOP) with yeast led to decrease dry matter content. After internal metabolism and respiration of yeast, some amounts of carbon in orange pulp goes out as carbon dioxide, so the DM percentage of treated orange pulp decreases. Dadvar et al. (2015) reported a decrease in dry matter of lemon pulp treated with yeast. Also, there was decrease in organic matter content after treatment. It could noticed that Ash content tended to increase. Results agree with finding of Ezekiel *et al.* (2010) who reported an increase in ash content of the fermented cassava peels during submerged fermentation of cassava peels with *Trichoderma* *viride*. There was a decrease in crud fiber content after treatment and this may be due to the possible secretion of some extracellular enzymes such as amylase and cellulose into the substrates which break the starch and other polysaccharides into simpler sugars that are easily metabolized by yeast as a source of carbon. These results agree with the finding of Oboh and Akindahunsi (2003) who treated cassava product by *S. cerevisiae*. On the other hand, crude protein content of orange pulp significantly increased after processing. It may be attributed to the corresponding increase in the microbial biomass resulting from growth and multiplication of the yeast inoculum, *S. cerevisiae*. Yeasts generally produce protein from starchy materials such as sweet potatoes and cassava peels. Results agree with Amande T.J and Itah, A.Y. (2011) who observed increase in protein level in cassava products due to the ability of *S. cerevisiae* to hydrolyze complex carbohydrate into sugars that serve as carbon source in synthesizing microbial biomass. CF fraction as neutral detergent fiber (NDF) and acid detergent fiber (ADF)of treated orange pulp appeared significantly ($p < 0.05$) higher after processing with *S. cerevisiae*. These results are in agreement with Scerra *et al.* (2000) who reported that NDF and ADF of citrus increased after processing. Also, treatment caused a significant ($P<0.05$) increase in fat content. which could attribute to the possibility that fungus could secrete microbial oil. This assertion agrees with earlier findings of Akindumila and Glatz (1998) that some microbes could produce microbial oil during fermentation. The increase in the ash content may not be a product of fermentation (Oboh 2006).

The metabolisable energy(ME) of pulp significantly ($p < 0.05$) decreased as shown in Table (1). Kayouli and Stephen (2000) reported that citrus wastes contain high-energy content. They reported that the energy content recorded 10.3 and 2.4 Mcal/kg of dry and wet pulp, respectively.

Data presented in table (2) showed the chemical composition of experimental rations beside berseem hay, treated orange citrus pulp with yeast. Different rations have nearly the same composition. However, it could notice different levels of citrus pulp on rations, but all of them nearly having the same chemical composition.

Nutrients digestibility and feeding values.

The results of digestibility coefficients, daily feed intakes and total DM intakes are shown in Table (3). It could noticed that total DM intake (953, 964 and 974 g DM for T1 , T2 and T3, respectively) increased with increasing treated pulp in the experiment. . The results agree with Henrique et al. (2003) who used diets with high concentrate contents and increasing levels of citrus pulp (0, 25, 40 and 55%) as they observed an increase in DMI, probably due to a higher citrus pulp assimilation by animals, or due to citrus pulp composition variations resulting from processing. In addition, fungal feed additives based on S. cerevisiae increased feed intake rather than altering feed conversion efficiency. Therefore, the main effects of fungal feed additives could regarded as intake-driven. Many factors known to influence appetite like palatability, the rate of fiber digestion, the rate of digesta flow, and protein status. The fungal products certainly have a pleasant odor and the ability of yeast to produce glutamic acid which of benefit to the taste of feedstuffs supplemented with yeast culture.

The digestibility of DM not affected by different levels of TOP. The OM digestibility showed somewhat higher values with increasing levels of TOP, which has different fermentation rates that caused improvement in OM digestibility (Lashkari & Taghizadeh, 2015). These effects might attributed either tohighly digestible NDF or high content of nonstructural carbohydrate mainly comprised by neutral detergent soluble fiber of OP. In contrast, Bueno et al. (2002) showed that OM digestibility did not respond to different levels of treated orange pulp .

The data indicate that there was significant difference ($P<0.05$) in CP digestibility as the ratio of replacement of TOP increased, being 1.99% and 3.72% for T2 and T3 compared with control. Digestibility of crude protein in citrus pulp is around 85% of that in corn. In general, fermented feedstuffs have better digestibility, which due to

Table (3): Daily feed intake, digestibility coefficient and feeding values of experimental rations.

	Treatments			
Items	**T1**	**T2**	**T3**	**± SE**
Daily feed intake (g DM / h)				
CFM	570	468	355	--
BH	383	376	380	--
TOP	----	120	239	--
Total DM intake	953	964	974	5.20
Digestibility coefficients (%).				
DM	76.13	75.90	74.70	0.40
OM	70.10^{b}	72.42^{ab}	73.87^{a}	0.65
CP	72.52^{c}	73.97^{b}	75.22^{a}	0.56
CF	64.33^{b}	66.46^{a}	67.80^{a}	0.65
EE	72.22	72.20	71.90	0.49
NFE	73.25^{b}	74.10^{ab}	75.07^{a}	0.34
NDF	55.32^{b}	58.15^{a}	59.73^{a}	0.70
ADF	56.87^{b}	60.43^{a}	61.98^{a}	0.87
Feeding values on DM basis (%).				
TDN	66.20	67.02	67.90	0.42
DCP	9.74	9.91	10.10	0.28

a,b,c : Means of different superscripts in the same row are significant ($P<0.05$) different.

variety of microorganisms and their enzymes (McDonald et al., 2011). Miron et al. (2002) observed that replacing 11% dry citrus pulp to corn seeds, in total mixed ration of dairy cows, resulted in better rumen condition for microorganism and increased digestibility of crude protein. In addition, processing of orange pulp with *S. cerevisiae* increased digestibility of crude protein, which consequently increased crude protein available in the rumen for microorganism utilization. Meanwhile, yeast can stimulate rumen proteolytic bacteria (Habeeb, 2006).

Crude fiber digestibility significantly ($p<0.05$) increased for sheep fed T1 or T2, being 66.46 and 67.8%, respectively compared with control. This positive effect may due to replacing starchy concentrates by feeds rich in easily degradable cell walls such as OP which generally had been associated with a more favorable rumen environment for cellulolytic bacteria and better capacity of yeast cells to scavenge oxygen. Although rumen known as anaerobic, dissolved oxygen in this microenvironment simulates the growth of cellulolytic bacteria, which improve fiber degradation (Barrios-Urdaneta et al., 2000). While there was insignificant difference ($P<0.05$) in EE digestibility between control and other groups. NFE digestibility recorded higher significant ($p<0.05$) value with T3 than T1 while the difference between T1 and T2 in NFE digestibility were not significant. The average value of NFE digestibility was close to that reported by Detmann et al. (2006).

In addition, there was significant (P<0.05) increase in digestibility of NDF and ADF for lambs fed diet containing OP. This improve of digestibility might be attributed to differences in their composition of cell wall.

Forages are rich in lignified secondary cell walls, while cell walls of by-product feeds, such as citrus pulp, are not lignified (Miron et al., 2002). Because citrus has high soluble carbohydrates and lack lignin, it highly fermented in the rumen and its total digestible nutrients was between 74% and 83% (Scerra et al., 1999). Similarly, it has been demonstrated that NDF digestibility increased linearly with increasing replacement of CFM by OP (Bhattacharya & Harb, 1973). They reported also that inclusion of OP in the diets increased the fiber digestibility from 34% to 65%. Likewise, improvement of the digestibility of these fractions seems to be associated with the low indigestible ADF and indigestible lignin in cell wall content of OP (Lashkari &Taghizadeh, 2013). The high fermentable cell wall fractions of citrus pulp, or diets containing OP, might lead to increase digestion of NDF. . Respecting data of feeding values, it showed no significant difference in TDN among all groups. This may be due to that forages rich in lignified secondary cell walls, while the cell walls of by-product feeds, such as citrus pulp, are not lignified (Miron et al., 2002). Because citrus pulp has high soluble carbohydrates and lack lignin, its fermentation in the rumen is high and its total digestible nutrients (TDN) was between 74% and 83% (Scerra et al., 1999). DCP in all groups hadn't significant difference. Highfill *et al*., (1987) reported that efficiency of microbial protein synthesis improved in the rumen of mature cows when citrus pulp used as a supplement (218 g/kg of DM diet) for fescue hay compared with a similar level of corn.

Rumen fermentation characteristics are presented in Table (4). It noticed that pH of ruminal fluid not differ significantly with increase replacement of CFM by TOP. Meanwhile, these pH values are within the physiological range of rumen pH. The pH-stabilizing effect on live yeasts could attribute to promoting the use of lactic acid by lactate-utilizing bacteria such as *Selenomonas ruminantium*. This finding agree with finding of Brossard et al. (2006) that yeast efficient in stabilizing rumen pH by stimulating ciliate entodiniomorphid protozoa, which are known to rapidly engulf starch granules.

Table (4): Effect of feeding the experimental rations on some rumen Parameters of lambs.

ITEMS	T1	T2	T3	±SE
pH	6.89	6.54	6.08	0.17
NH_3-N(mg/ L)	123.65[a]	110.22[b]	106.87[c]	2.59
TVFA's(m/M)	110[c]	123[b]	146[a]	5.48
Acetate	56.87[b]	59.42[ab]	60.51[a]	0.67
Propionate	31.00[a]	28.59[ab]	26.34[b]	0.80
Butyrate	17.56	18.78	19.95	0.44
Microbial protein synthesis	19.46[c]	21.76[b]	25.83[a]	1.00

a,b,c : Means of different superscripts in the same row are significant (P<0.05) different.

The ruminal ammonia-N concentration decreased when TOP inclusion level increased, which agree with findings of Piquer et al. (2009). The lowest ruminal ammonia-N concentration in lambs fed 100% OP compared to other experimental diets could explain by the higher amount of NDF and pectins, because the ruminal bacteria fermenting fiber utilize mostly N from ammonia source (Russell et al., 1992; Hristov& Ropp, 2003). In addition, the lower ruminal ammonia-N produced by citrus by-products diets might relate to higher fermentation rate and microbial growth (Lashkari & Taghizadeh, 2015). Meanwhile, Casper and Schingoethe (1989) and Reynolds et al. (1997) reported that ruminal NH3-N concentration was lower when cows fed diets with rapidly fermented barley than those fed diets supplemented with corn as the energy substrate for ruminal microbes. The use of NH3-N as carbon skeletons for de novo amino acid synthesis can result in a simultaneous decrease in media concentrations of both components during de novo amino acid synthesis.

The ruminal volatile fatty significantly ($p<0.05$) increased with replacing TOP to CFM compared with control, this may be due to that yeast supplementation increase number of ruminal cellulolytic bacteria and their activities, thus increase forage degradability and increase the flow of microbial protein as well and may alter patterns of VFA's formation (Dawson and Tricarico, 2002). Also, it provide vitamins to support the growth of rumen fungi and stimulate utilization of hydrogen by ruminal acetogenic bacteria (Oezturek et al., 2005). Yeast also stimulate cellulolytic bacteria in the rumen, thus increased fiber digestion and flow of microbial protein from the rumen.

The data revealed that concentration of acetate significantly ($P<0.05$) increased with increasing TOP level, being 56.78, 59.42 and 60.51 (ml /M) for animals fed ration T1, T2 and T3 , respectively. On contrary, propionate concentration significantly ($P<0.05$) decreased with increasing TOP level in ration. On the other hand, butyrate concentration showed little increase with no significant difference (Table 4). A similar trend also reported by Piquer et al. (2009). Similar trend was observed by Ben- Ghedalia et al. (1989), who reported increase of acetate and decrease of propionate in the rumen fluid of Merino lambs when citrus pulp replaced barley grain in the diet. As could be expected for starchy diets, the control diet resulted in higher propionate and lower acetate proportions than the citrus enriched diets.
There was significant ($P<0.05$) increase in microbial protein synthesis for T2 andT3 compared with control, which may explained either by the competition between *S. cerevisiae* cells and bacteria for energy supply or the direct inhibitory effect of yeast's small peptides on targeted peptidases. When adequate balance found between soluble nitrogen and carbohydrate supply, *Saccharomyces cerevisiae* could enhance microbial growth and decrease nitrogen loss.

The main effects of the experimental rations on blood parameters of growing sheep are shown in Table (5). Data show no significant differences in both blood glucose and total triglycerides among different treatments, while blood urea, total protein and total cholesterol concentrations showed significant differences. It could be noticed that using TOP at higher level (40%) in CFM led to lower concentration of blood urea and higher concentration of total protein and total cholesterol. Same results obtained with Bhattacharya &Harb (1973) who reported that there was no significant difference in plasma glucose of lambs fed 0, 20, 40 and 60% of citrus pulp. However, Oni et al. (2008) showed that plasma glucose concentration quadratic responded to increasing the proportion of TOP in the diet.

Table (5): Effect of feeding the experimental rations on some blood Parameters (mg/dL).

ITEMS	T1	T2	T3	±SE
Blood Urea	13.04^{a}	12.54^{a}	11.23^{b}	0.30
Blood Glucose	60.54	61.21	61.34	0.34
Total protein	72.65^{b}	72.98^{b}	74.63^{a}	0.42
Total cholesterol	63.80^{b}	66.47^{a}	68.01^{a}	0.68
Total triglycerides	21.90	22.14	22.27	0.27

treatments.

Table (6): Effect of feeding the experimental rations on animal performance and efficiency.

ITEMS	T1	T2	T3	±SE
No. of animals	6	6	6	
Experimental period, day	90	90	90	
Av. initial body weight LBW, Kg	18.44	18.11	18.23	0.11
Av. final body weight LBW, Kg	30.59	30.97	31.16	0.24
Av. total LBW, Kg	12.15	12.86	12.93	
Av. daily LBW gain, gm	135^{b}	142^{a}	144^{a}	2.83
Av. Daily feed unit intake:				
gm DM	953	964	974	
gm TDN	642	643	652	
gm DCP	93	96	98	
Feed utilization efficiency:				
Kg DM/ Kg gain	7.059	6.741	6.764	
Kg TDN/ Kg gain	4.756	4.497	4.528	
Kg DCP/ Kg gain	0.689	0.671	0.681	
Feed cost economical efficiency				
Cost of feed intake(LE)	2.97	2.82	2.63	
Price of Kg weight gain	6.75	7.15	7.20	
Feed cost/ kg weight gain	22.00	19.72	18.26	
Economical efficiency	2.27	2.54	2.74	
Improvement (%)	-	11.89	20.70	

a,b,c : Means of different superscripts in the same row are significant (P<0.05) different.

- Based on the assumption that the price of one ton of berseem hay was 1600,LE; CFM was 3670, LE: treated orange plup (TOP)1800,LE while the price of body weight gain was 50LE

The lowest blood urea in lambs fed 40% citrus pulp (TOP) compared to other groups might be due to the better synchronization between carbohydrate and protein sources. The lower blood urea in lambs fed TOP took the same trend of lower ammonia-N as describe in Table (5). It suggested that synchronization of the both rate of carbohydrate degradation and nitrogen release in the rumen would increase the amount of retained nitrogen for growth and thus reduce the concentration of rumen ammonia-N (Sniffen et al., 1992). Blood total protein increased linearly with increasing (TOP) in concentrate feed mixture. These results are in agreement with Oni et al. (2008) who reported that total plasma protein increased linearly with increasing levels of citrus pulp. They added that the higher blood total protein in lambs fed 33% orange pulp (OP) might reflect the higher supply of digestible protein in small intestine. Highfill et al. (1987) reported that efficiency of microbial protein synthesis improved in the rumen of mature cows when citrus pulp used as supplement (218 g/kg of DM diet) for fescue hay compared with a similar level of corn. The results are also in line with Lunn& Austin (1983) who reported that adequate digestible protein was responsible of increasing the plasma protein concentration. Blood cholesterol concentration increased in lambs fed TOP compared with the control group. In agreement with these findings, Belibasakis & Tsirgogianni (1996) reported that diets containing 20% citrus pulp increased total plasma cholesterol. Accordingly, the high citrate content in the citrus pulp increases cytoplasmic citrate and might provide a substrate for cholesterol de novo synthesis and, possibly, some activation of acetyl-CoA carboxylase.

Animal performance and efficiency.

Data presented in table (6) showed higher total and daily gain for animals fed T3 ration, which contained 40% TOP, being 12.93 kg and 144 gm, respectively. However no significant difference found between T2 and T3 in daily gain, but adding TOP to experimental ration led to limited higher daily gain. It might be due to both higher digestibility and feeding value of T3 ration. On the other hand, animals fed T2 showed the best-feed efficiency followed by those fed T3 and T1 with no significant differences. The cost of feed intake recorded 2.97, 2.82 and 2.63 LE with rations T1, T2 and T3, respectively, while feed cost /Kg weight gain were 22.00, 19.72 and 18.26 LE for the same respective rations, thus the lowest feed cost to get one kg weight gain was at T3 rations containing 40% TOP. At the same time, the group fed T3 showed the best economic efficiency (2.74) compared with others. In this respect, improvement in economic efficiency recorded 11.89 and 20.70% with groups fed rations T2 and T3 containing 20 and 40% treated orange pulp (TOP), respectively.

Similarly, Bueno et al. (2002) found that Saanen kids fed different proportion of orange pulp (OP) showed a quadratic effect and that the highest ADG observed in kids fed diet containing 42.3% OP.

CONCLUSION

Treated orange citrus pulp could replace 40% of concentrate feed mixture without any adverse effect for growing lambs. Moreover, orange citrus pulp treated with *Saccharomyces cerevisiae* is better for feeding lambs instead of concentrate feed mixture and could improve the feeding values. Meanwhile, the lowest feed cost and the highest economic efficiency were obtained by these

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تأثير معامله تفل البرتقال بالخميرة على معدلات النمو ومعاملات الهضم وقياسات الدم فى الاغنام البرقى

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تم اختيار 18 حمل برقى وتقسيمهم على ثلاث مجموعات متماثله طبقا للوزن واستمرت تغذيتهم على العلف المركز ودريس البرسيم بنسبة 60:40 لمدة 90 يوم . وقد تم استبدال جزء من العلف المركز بتفل البرتقال المعامل بالخميرة بنسب صفر،20، 40% فى المجموعات الثلاثه على التوالى . اظهرت النتائج زيادة معنوية فى معدل النمو اليومى (144جرام) للمجموعة الثالثه . كان تأثير الاستبدال ايجابيا على معاملات الهضم لكل من المادة العضوية ، البروتين ،الالياف و المستخلص الخالى من الازوت، كما ادت المعامله الى زيادة القيمه الغذائيه معبرا عنها بالمركبات الغذائيه المهضومة و البروتين المهضوم . انخفضت قيم ال pH فى سائل الكرش وانخفضت الامونيا معنويا فى المجموعة الثالثة . من ناحيه اخرى تأثرث قيم يوريا الدم والبروتين والكلوسترول ولكن كانت قيمهم فى النطاق الطبيعى . من نتائج هذه الدراسة نوصى باستخدام نسبة 40% من تفل البرتقال المعامل بالخميرة مكان العلف المركز فى علائق الحملان النامية حيث يؤدى ذلك الى زيادة معدل النمو اليومى وانخفاض فى التكاليف مع ارتفاع الكفاءة الغذائيه و الاقتصادية دون تاثير سلبى على نشاط الكرش او قياسات الدم.