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USE OF TOMATO POMACE AND/OR ORANGE PULP SUPPLEMENTED CORN SILAGE FOR ANIMAL FEEDING

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ABSTRACT: *Corn silages were made either un-supplemented (control, C) or supplemented with tomato pomace (TP) and/ or orange pulps (OP) at the levels of 10, 15 or 20%. The effect of the experimental silages on nutrients digestibility, rumen fermentation and some blood parameters of sheep were tested. Twelve male Ossimi rams, averaged 63kg live body weight, were assigned to three 4×4 Latin squares. The first was used to test corn silage supplemented with 0, 10, 15 or 20% TP; the second one was designed to test corn silage supplemented with 0, 10, 15 or 20% OP; the third were used to test corn silage supplemented with both pulps (TOP) at 0, 10, 15 or 20%, half of it from each source. Results indicated that the addition of TP and/or OP to corn silage gave the best properties of silage until the level of 20%. The digestibility of CP, CF, NFE and EE increased when animals were fed silage containing 10% tomato pomace (TP_{10}). The digestibility of DM, CP and NFE increased when animals were fed silage containing 10% orange pulp (OP_{10}) while the digestibility of CF and EE increased in the silage containing 15% orange pulp silage (OP_{15}); differences were significant (P<0.01). The digestibility of DM, CP, EE and NFE increased when animals were fed silage containing 5% of both tomato pomace and citrus pulps (TOP_{10}). The digestibility of CF increased in ration containing 7.5% of each tomato and orange pulp silage (TOP_{15}). The increase in the nutrients digestibility led to an increase in the nutritive value (TDN and DCP). Feeding silages containing 10% or 15% tomato and/or orange pulps led to an improvement in the rumen VFA and NH_3-N concentration. The results obtained showed that blood parameters were in the normal range.*

***Key words**: Tomato pomace, orange pulp, digestibility, rumen fermentation, sheep.*

INTRODUCTION

One of the main reasons for the high price of animal products (milk and meat) in Egypt is the increase of prices of diet ingredients where the feeding of ruminants in Egypt depends mainly on concentrates which have high price due to lack of pasture. Agricultural by-product as an alternative source to these concentrates should be considered as a source of energy and protein. Tomato pomace (TP) and orange pulp (OP) are the most important industrial by-products which are produced in Egypt in large quantities. Tomato pomace is considered a good source of protein and OP is considered a good source of energy. In recent years, because of economic considerations and waste technology, by-products took more attention by livestock producers and animal nutritionists (Grasser *et al*., 1995). The total waste produced from tomatoes from world production was estimated to be 3.70 million ton/year (FAO, 1991). The chemical composition of final pomace and pulp are linked to the morphology of the original feed stock and the extraction technique used. Although TP and OP vary in nutrient density, effective processing can improve their nutritive value. According to NRC (2001), OP is low in protein but it could serve as a useful energy source for ruminants. In contrast, Elloitt *et al*. (1981) demonstrated that TP has the potential to be a good source of protein, but may be limited in energy due to the high fiber content. The objective of the present work was to evaluate the effect of corn silage supplemented with either TP and/or OP in different levels on nutrients digestibility, nutritive value, rumen fermentation and blood metabolites of sheep.

MATERIALS AND METHODS

This study was carried out at the Animal Production Farm of the Faculty of Agriculture, Menoufiya University, in order to study the effect of feeding TP and OP supplemented-silage to sheep. This experiment lasted for 32 weeks. Corn silages were made either un-supplemented (control, C) or supplemented with TP and/or OP at the levels of 10, 15 or 20%. Twelve male Ossimi rams, averaged 63kg live body weight, were assigned to three

4×4 Latin squares. The first was used to test corn silage supplemented with either 0, 10, 15 or 20% tomato pomace (C, TP_{10}, TP_{15} , TP_{20}); the second one was designed to test corn silage supplemented with either 0, 10, 15 or 20% orange pulp (C, OP_{10}, OP_{15}, OP_{20}); the third were used to test corn silage supplemented with both pulps at 0, 10, 15 or 20%, half of it from each source (C, TOP_{10}, TOP_{15}, TOP_{20}). Animals received their nutrients requirements according to NRC (2001). All animals were fed 1.25 kg concentrate feed mixture (CFM) and 2.5kg silage. Animals were fed twice daily at 8.00 and 14.00 hr. Water was available all the time. The complete chemical composition of the experimental rations is shown in Tables (1 and 2). Table (2) also shows the quality of different type of silage.

Table 1: Chemical composition of the ingredients used in the present study.

Item [(2)]	Tomato Pomace (TP)	Orange Pulp (OP)	CFM[(1)]
	--------------------------------(%) -------------------------------		
DM	14.25	18.84	90.11
	On DM basis		
OM	92.99	94.69	89.91
CP	20.60	6.76	16.18
EE	10.97	3.03	3.62
CF	26.41	12.22	9.25
NFE	35.01	72.68	60.86
Ash	7.01	5.31	10.09

(1) CFM, concentrate feed mixture (wheat bran 22%; yellow corn 40%; un-decorticated cotton seed meal 21%; soy bean meal 14%; limestone 1.7%; salt 1%; minerals and vitamins mixture 0.3%).
(2) DM, dry matter; OM, organic matter; CP, crude protein; EE, ether extract; CF, crude fiber; NFE, nitrogen-free extract.

Table 2: Chemical composition of the experimental silage.

Item	C	TP_{10}	TP_{15}	TP_{20}	OP_{10}	OP_{15}	OP_{20}	TOP_{10}	TOP_{15}	TOP_{20}
	--(%) ---									
DM	34.11	32.64	32.02	30.89	32.72	31.91	31.29	33.03	32.99	30.80
On DM basis										
OM	91.33	91.46	91.64	91.88	91.52	91.73	91.82	91.52	91.72	91.81
CP	9.89	12.98	14.87	15.59	12.22	13.38	14.01	12.93	15.28	15.11
EE	2.62	3.37	4.12	4.15	2.63	2.68	2.71	2.98	3.16	3.27
NFE	33.31	44.85	43.64	43.36	46.35	46.22	46.22	45.40	43.97	44.11
CF	45.51	30.26	29.01	28.78	30.32	29.45	28.88	30.21	29.31	29.32
Ash	8.67	8.54	8.36	8.12	8.48	8.27	8.18	8.48	8.28	8.19
Quality characteristics of the experimental silage										
*p*H	4.35	4.15	4.09	4.12	4.13	4.16	4.23	4.10	4	4.24
Lactic acid g/100g DM	5.22	6.13	6.55	6.12	6.78	6.79	6.43	6.22	7.04	6.49

C, corn silage; TP_{10}, C+10% TP; TP_{15}, C+15% TP; TP_{20}, C+20% TP; OP_{10}, C+10% OP; OP_{15}, C+15% OP; OP_{20}, C+20% OP; TOP_{10}, C+5%TP+5%OP; TOP_{15}, C+7.5%TP+7.5%OP; TOP_{20}, C+10%TP+10%OP.

During the experimental period, animals of each group were placed in the metabolic cages as described by Maynard *et al*. (1979) allowing quantitative fecal collection. Animals were adapted to the cages for 14 days followed by 5-day collection period. Fecal samples were dried at 60ºC to70ºC for 24 h in a forced air oven. Dried samples of tested feeds and feces were ground through 1mm screen sieve and kept until chemical analysis for crude protein, crude fiber, ether extract and ash according to the methods of AOAC (2000).

Rumen fluid samples were collected for two successive days from different locations and at different depths in a glass container via a small rubber tube using gentle mouth suction. Rumen fluid was sampled before and at 2, 4, and 6 hours after feeding. The samples were filtered through four layers of cheesecloth and homogenized. Samples were preserved by the addition of 0.1 ml of concentrated hydrochloric acid to 5 ml of rumen liquor for later analysis of ammonia-N. Rumen fluid used for analysis of volatile fatty acids (VFA) was prepared by combining 5 ml of rumen fluid with 1 ml orthophosphoric acid. The rumen *p*H was measured immediately after sampling using a digital *p*H meter. Free ammonia-N and total VFA were determined in the rumen fluids as described by Ahmed (1976). Blood samples (20 ml) were taken from the jugular vein of each animal at the end of the collection period of each trail before morning meal. Blood samples were collected in vacutainer tubes and left at room temperature for 2hrs, centrifuged at 3500 rpm for 15 minutes to obtain the serum, which was stored at -20^{o} C till analysis. Blood serum was analyzed using special kits for total protein (Cannon, 1974), albumin (Doumas *et al*., 1975) and GOT and GPT (Reitman and Frankel, 1957). The obtained results were statistically analyzed according to SPSS, (2010). The following models were used:

$Y_{ijk} = \mu + R_i + C_j + T_k + e_{ijk}$

Where:

Y_{ijk} = the parameter under analysis; μ = general mean; R_i = effect of row; C_j = effect of column; T_k = effect of treatment; e_{ijk} = random error assumed to be independent normally distributed with mean and variance σ2.

RESULTS AND DISCUSSION

Digestibility coefficient and nutritive values of the experimental rations:

Regarding the effect of tomato pomace supplementation, digestibility of DM was higher (P<0.01) for rations TP_{10} and TP_{15} than the control (Table 3). Digestibility of CP in ration TP_{10} was the highest followed by control ration, but the differences were not significance. Differences were significant (P<0.01) between the ration TP_{10} and ration TP_{20}. Digestibility of CF in ration TP_{10} was higher (P<0.01) than the rest of the experimental rations; digestibility of NFE followed the same trend.

The digestibility of EE was the highest (P<0.01) in TP_{10} than the other rations. The improved digestibility (Table 3) led to an improved TDN and DCP (P<0.01) being highest for TP_{10} than ration TP_{15} and TP_{20}. Table (3) also revealed the effect of orange pulp supplemented silages on nutrient digestibility; ration OP_{10} was higher in digestibility of DM and CP than rations OP_{15} and OP_{20} but there was no difference between them and the control ration regarding DM digestibility. Ration OP_{20} showed higher (P<0.01) digestibility of CF but it does not differ than OP_{15} being 65% and 64.53%, respectively. The ration OP_{10} recorded the highest digestion coefficient of the NFE being 68.06%, followed by the control ration (67.99%); differences between them and the rations OP_{15} and OP_{20} were significant (P<0.01). Ration OP_{20} had the highest (P<0.01) digestibility of EE. The TDN of ration OP_{10} was the highest (P<0.01) than the other rations, while DCP of ration OP_{15} was highest (P<0.01) followed by OP_{10}. The effect of ration containing both tomato and orange pulp are presented in Table (3). Ration TOP_{10} had higher (P<0.01) digestibility of DM, CP and NFE being 70.78, 69.62 and 68.90%, respectively. The ration TOP_{10} that contained 5% of each supplement increased TDN at (P<0.01) while DCP was high in ration TOP_{15} being 10.76% followed by ration TOP_{10} being 10.30%; differences were highly significant (P<0.01).

Table 3: Nutrients digestibility as affected by the dietary treatments.

ITEM	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.
DM%	C	66.24^{a}±0.61	0.01	C	71.22^{ab}±0.62	0.01	C	65.58^{b}±0.68	0.01
	TP$_{10}$	65.93^{a}±0.55		OP$_{10}$	71.95^{a}±0.61		TOP$_{10}$	70.78^{a}±0.72	
	TP$_{15}$	63.23^{b}±0.71		OP$_{15}$	69.72^{b}±0.79		TOP$_{15}$	65.40^{b}±0.57	
	TP$_{20}$	59.77^{c}±0.59		OP$_{20}$	67.46^{c}±0.68		TOP$_{20}$	62.49^{c}±0.69	
CP%	C	66.41^{ab}±0.96	0.01	C	70.64^{b}±0.55	0.01	C	69.02^{ab}±0.63	0.01
	TP$_{10}$	67.96^{a}±0.72		OP$_{10}$	72.83^{a}±0.49		TOP$_{10}$	69.62^{a}±0.52	
	TP$_{15}$	64.67^{bc}±0.84		OP$_{15}$	70.67^{b}±0.58		TOP$_{15}$	67.70^{b}±0.47	
	TP$_{20}$	63.20^{c}±0.95		OP$_{20}$	67.17^{c}±0.53		TOP$_{20}$	63.66^{c}±0.64	
CF%	C	62.26^{b}±0.47	0.01	C	67.17^{c}±0.53	0.01	C	61.52±0.67	NS
	TP$_{10}$	63.63^{a}±0.62		OP$_{10}$	61.71^{b}±0.84		TOP$_{10}$	62.18±0.68	
	TP$_{15}$	59.97^{c}±0.59		OP$_{15}$	64.53^{a}±0.69		TOP$_{15}$	63.24±0.59	
	TP$_{20}$	58.57^{d}±0.69		OP$_{20}$	65.00^{a}±0.78		TOP$_{20}$	62.17±0.74	
NFE%	C	69.98^{a}±0.50	0.01	C	67.99^{a}±0.53	0.01	C	68.64^{a}±0.73	0.01
	TP$_{10}$	70.91^{a}±0.62		OP$_{10}$	68.06^{a}±0.68		TOP$_{10}$	68.90^{a}±0.61	
	TP$_{15}$	68.12^{b}±0.58		OP$_{15}$	65.33^{b}±0.54		TOP$_{15}$	65.64^{b}±0.75	
	TP$_{20}$	67.45^{b}±0.51		OP$_{20}$	61.58^{c}±0.61		TOP$_{20}$	66.11^{b}±0.59	
EE%	C	71.45^{b}±0.67	0.01	C	60.40^{c}±0.62	0.01	C	66.89^{a}±0.61	0.01
	TP$_{10}$	74.69^{a}±0.81		OP$_{10}$	62.16^{bc}±0.71		TOP$_{10}$	68.19^{a}±.049	
	TP$_{15}$	72.05^{b}±0.68		OP$_{15}$	63.55^{b}±0.64		TOP$_{15}$	66.94^{a}±0.46	
	TP$_{20}$	68.36^{c}±0.75		OP$_{20}$	67.67^{a}±0.58		TOP$_{20}$	63.72^{b}±0.62	
TDN%	C	63.70^{b}±0.39	0.01	C	61.97^{b}±0.29	0.01	C	62.87^{b}±0.48	0.01
	TP$_{10}$	66.10^{a}±0.38		OP$_{10}$	63.19^{a}±0.31		TOP$_{10}$	64.50^{a}±0.50	
	TP$_{15}$	62 .90^{b}±0.35		OP$_{15}$	62.31^{b}±0.30		TOP$_{15}$	62.54^{b}±0.49	
	TP$_{20}$	61.71^{c}±0.37		OP$_{20}$	60.06^{c}±0.29		TOP$_{20}$	61.97^{b}±0.43	
DCP%	C	8.72^{b}±0.14	0.01	C	9.27^{c}±0.08	0.01	C	9.06^{c}±0.09	0.01
	TP$_{10}$	10.10^{a}±0.15		OP$_{10}$	10.45^{a}±0.09		TOP$_{10}$	10.30^{b}±0.07	
	TP$_{15}$	10.05^{a}±0.13		OP$_{15}$	10.62^{a}±0.06		TOP$_{15}$	10.76^{a}±0.06	
	TP$_{20}$	9.97^{a}±0.14		OP$_{20}$	10.19^{b}±0.09		TOP$_{20}$	10.05^{b}±0.09	

C, corn silage; TP$_{10}$, C+10% TP; TP$_{15}$, C+15% TP; TP$_{20}$, C+20% TP; OP$_{10}$, C+10% OP; OP$_{15}$, C+15% OP; OP$_{20}$, C+20% OP; TOP$_{10}$, C+5%TP+5%OP; TCP$_{15}$, C+7.5%TP+7.5%OP; TOP$_{20}$, C+10%TP+10%OP.

Romero and Molina (2013) reported that apparent digestibility of DM (P = 0.02) and OM (P = 0.02) decreased for diets including tomato and cucumber- based FB (feed blocks) with no difference between AC (alfalfa hay plus concentrate in a 1:1 ratio) and ACB (barley grain). The apparent digestibility of fat decreased (P =0.05) in animals fed diets including tomato and barley based FB with no difference between AC and

ACC (wastes of cucumber fruits). The apparent digestibility of CP, NDF, and ADF was similar for all the studied diets. They also observed a reduction in OM, DM, and fat digestibility when FB was included. Digestible energy decreased with barley-based FB compared with AC, which agrees with previous observations (Islam *et al*., 2000; Tovar *et al*., 2007). Our results agree with Ben Salem and Znaidi (2008) who noted that partial replacement of concentrate with either olive cake or tomato pulp-based FB decreased DM and OM digestibility in Barbarine lambs. In addition, it is generally accepted that increased concentrate in ruminant diets leads to a greater DM and OM digestibility (Molina *et al*., 2000); in this experiment, the lack of differences in fiber digestibility in goats fed FB may be explained by both pH values and total bacteria abundance in the rumen. The CP apparent digestibility observed in goats fed diets containing wastes fruits based FB was greater than that reported in Awassi sheep fed diets containing 34% of tomato pomace or olive cake (Abbeddou *et al*., 2011); they showed that for some nutrients, digestibility tended to increase when ensiled mixed tomato and apple pomace was substituted in diets ($P<0.05$). Chemical component of the diet has a major effect on nutrient digestibility. It was showed (Ibrahem and Alwash, 1983; Gasa *et al*., 1989; Ojeda and Torrealba, 2001) that animals fed tomato pomace improved the nutritive value of the diet due to more digestible content of protein (61.2%) and ether extract (86.3%).

Macías *et al*. (2010) indicated that the apparent digestibility and intake of DM, OM, and CP increased with the inclusion of citrus pulp at 75% of the diet DM. The improvements observed in digestibility of the diet may have been due to the better nutrient profile; they found that IVDMD and IVOMD were improved with the increasing levels of dried citrus with high soluble carbohydrates in the rumen, however, Hernández *et al*. (2012) reported that pulp had linear effect ($P<0.01$) on digestibility. Abdel Gawad *et al*. (2013) reported that nutritive values, DM, OM and CP digestibility were insignificant among all the experimental rations where the experimental ration contained 30% citrus pulp silage plus70% concentrate feed mixture (CFM) and 45% citrus pulp silage plus 55% CFM. Macedo *et al*. (2007) reported OM digestibility of the diets with 50% fresh orange pulp (73.35%). Branco *et al*. (1994) reported digestibility of 55.93 and 56.42% for diets with 20 and 40% fresh orange pulp, respectively. Also, Wainman and Dewey (1988) reported that crude protein digestibility values for citrus pulp ranging from 40 to 65%. Farzad and Rahim (2012) showed that DM and OM digestibility tended to increase ($P<0.05$) with add ensiled mixture of tomato and apple pomace in the diet. It was showed by several studies (Ibrahem and Alwash, 1983; Ojeda and Torrealba, 2001) that tomato pomace can improve the nutritional value of the diet; due to its content in more digestible protein (61.2%) and ether extract (86.3%). Rumsey (1978) reported that apple pomace is similar to corn silage for total digestible nutrients content as pectin, pentosans and ether extract. Generally, the improvement in the feeding value for diets containing ensiled mixture of tomato and apple pomace was mainly due to the presence of more nitrogen free extract (NFE) and appreciable quantities of soluble carbohydrates (NRC, 2001; Hang and Woodams, 1986; Rumsey, 1978).

Rumen fermentation:

Table (4) presents the rumen pH values of sheep fed silages supplemented with tomato pomace and/or orange pulp. There were no significant differences between the experimental diets at 2 hours, while significant differences at 4 h between the ration TP_{20} and rations TP_{10} and TP_{15}. Differences were significant ($P<0.05$) between diets TOP_{15} and TOP_{20} at 4 hours post-feeding. The same trend was found at 6 h. Differences ($P<0.05$) were found between ration OP_{15} and OP_{20}, as well as between the rations TOP_{15} and TOP_{20}.

Table 4: Rumen pH in sheep as affected by dietary treatments

Sampling Time	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.
0 hr	C	6.83^{ab}±0.05	0.01	C	6.58^{a}±0.04	0.01	C	6.61±0.05	NS
	TP_{10}	6.69^{bc}±0.06		OP_{10}	6.49^{ab}±0.05		TOP_{10}	6.56±0.06	
	TP_{15}	6.67^{c}±0.07		OP_{15}	6.37^{bc}±0.04		TOP_{15}	6.48±0.05	
	TP_{20}	6.89^{a}±0.04		OP_{20}	6.32^{c}±0.03		TOP_{20}	6.52±0.04	
2 hr	C	6.46±0.04	NS	C	6.46±0.04	NS	C	6.49±0.04	NS
	TP_{10}	6.47±0.07		OP_{10}	6.43±0.02		TOP_{10}	6.46±0.03	
	TP_{15}	6.38±0.06		OP_{15}	6.38±0.03		TOP_{15}	6.38±0.02	
	TP_{20}	6.45±0.04		OP_{20}	6.47±0.03		TOP_{20}	6.50±0.03	
4 hr	C	6.33^{ab}±0.03	0.01	C	6.36^{a}±0.02	0.01	C	6.47^{ab}±0.04	0.05
	TP_{10}	6.29^{b}±0.02		OP_{10}	6.28^{ab}±0.03		TOP_{10}	6.47^{ab}±0.02	
	TP_{15}	6.25^{b}±0.01		OP_{15}	6.23^{b}±0.01		TOP_{15}	6.41^{b}±0.02	
	TP_{20}	6.42^{a}±0.03		OP_{20}	6.37^{a}±0.03		TOP_{20}	6.56^{a}±0.04	
6 hr	C	6.47^{b}±0.03	0.01	C	6.47^{ab}±0.03	0.05	C	6.48^{ab}±0.03	0.05
	TP_{10}	6.44^{b}±0.02		OP_{10}	6.42^{ab}±0.04		TOP_{10}	6.47^{ab}±0.04	
	TP_{15}	6.37^{b}±0.03		OP_{15}	6.37^{b}±0.02		TOP_{15}	6.41^{b}±0.02	
	TP_{20}	6.58^{a}±0.04		OP_{20}	6.52^{a}±0.03		TOP_{20}	6.56^{a}±0.03	

C, corn silage; TP_{10}, C+10% TP; TP_{15}, C+15% TP; TP_{20}, C+20% TP; OP_{10}, C+10% OP; OP_{15}, C+15% OP; OP_{20}, C+20% OP; TOP_{10}, C+5%TP+5%OP; TCP_{15}, C+7.5%TP+7.5%OP; TOP_{20}, C+10%TP+10%OP.

Farzad and Rahim (2012) reported that rumen pH were different (P<0.01) among diets containing ensiled mixed tomato and apple pomace. These trends are similar to those described by Rumsey (1978) who worked on supplementing apple pomace with non-protein nitrogen in gestating beef cows and fistulated steers, and Chumpawadee and Pimpa (2009) who tested the effect of some non-forage fiber sources such as tomato pomace in beef cattle nutrition. Oltjen *et al*. (1977) compared apple pomace with corn silage. Due to the high content of acids components of ensiled mixed tomato and apple pomace (pH, 3.5) a decrease of rumen pH was observed.

Table (5) show that ration TP_{15} was the highest in the production of the VFA at different sampling times; differences between TP_{15} and control ration at 0, 2 and 6 h post-feeding, while no differences between rations TP_{10} and TP_{15} were found at 0 time and at 2 h. Also no significant differences were found between ration TP_{15} and rations TP_{10} and TP_{20} at 4 and 6h. Table (5) also show that the ration OP_{15} was higher than the rations C, TP_{10} and TP_{20} in the production of VFA at 0, 2 and 6h, while at 4h, ration OP_{10} was the highest in the production of VFA (15.8 meq/dl); no difference between it and ration OP_{15}. Ration TOP_{15} were higher in the production of VFA from diets C, TOP_{10} and TOP_{20} at 0, 2 and 4 h; while at 6 h, ration TOP_{10} was the highest in the production of the VFA. The highest value of VFA was in ration OP_{15} after 4 h of feeding.

Table 5: Rumen VFA (meq/dl) in sheep as affected by dietary treatments

Sampling Time	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.
0 hr	C	$7.63^{b}\pm0.3$	0.01	C	$7.75^{c}\pm0.31$	0.01	C	$7.90^{ab}\pm0.35$	0.01
	TP_{10}	$9.28^{a}\pm0.35$		OP_{10}	$9.31^{b}\pm0.32$		TOP_{10}	$8.49^{b}\pm0.33$	
	TP_{15}	$9.42^{a}\pm0.4$		OP_{15}	$10.33^{a}\pm0.28$		TOP_{15}	$9.51^{a}\pm0.36$	
	TP_{20}	$7.29^{b}\pm0.38$		OP_{20}	$7.87^{c}\pm0.29$		TOP_{20}	$7.41^{c}\pm0.38$	
2 hr	C	$9.35^{c}\pm0.41$	0.01	C	$9.49^{c}\pm0.44$	0.01	C	$9.54^{b}\pm0.48$	0.01
	TP_{10}	$11.67^{ab}\pm0.5$		OP_{10}	$12.32^{b}\pm0.42$		TOP_{10}	$11.47^{a}\pm0.49$	
	TP_{15}	$12.61^{a}\pm0.42$		OP_{15}	$13.67^{a}\pm0.38$		TOP_{15}	$12.88^{a}\pm0.46$	
	TP_{20}	$10.96^{b}\pm0.46$		OP_{20}	$11.88^{b}\pm0.41$		TOP_{20}	$12.14^{a}\pm0.45$	
4 hr	C	$12.83^{b}\pm0.45$	0.01	C	$13.13^{b}\pm0.51$	0.01	C	13.09±0.45	NS
	TP_{10}	$14.40^{a}\pm0.48$		OP_{10}	$15.80^{a}\pm0.52$		TOP_{10}	13.55±0.47	
	TP_{15}	$15.64^{a}\pm0.46$		OP_{15}	$15.76^{a}\pm0.48$		TOP_{15}	14.39±0.46	
	TP_{20}	$14.57^{a}\pm0.49$		OP_{20}	$14.32^{ab}\pm.042$		TOP_{20}	13.69±0.43	
6 hr	C	$8.05^{b}\pm0.43$	0.01	C	$8.157^{b}\pm0.52$	0.01	C	$9.00^{b}\pm0.58$	0.01
	TP_{10}	$10.04^{a}\pm0.44$		OP_{10}	$11.01^{a}\pm0.51$		TOP_{10}	$12.03^{a}\pm0.59$	
	TP_{15}	$10.04^{a}\pm0.48$		OP_{15}	$11.19^{a}\pm0.44$		TOP_{15}	$11.45^{a}\pm0.54$	
	TP_{20}	$7.38^{b}\pm0.46$		OP_{20}	$7.97^{b}\pm0.52$		TOP_{20}	$10.55^{ab}\pm0.57$	

C, corn silage; TP_{10}, C+10% TP; TP_{15}, C+15% TP; TP_{20}, C+20% TP; OP_{10}, C+10% OP; OP_{15}, C+15% OP; OP_{20}, C+20% OP; TOP_{10}, C+5%TP+5%OP; TCP_{15}, C+7.5%TP+7.5%OP; TOP_{20}, C+10%TP+10%OP.

Ariza *et al*. (2001) reported that VFA profiles between the hominy feed and dried orange pulp treatments indicate differences in the pattern of fermentation between the carbohydrate sources. The molar proportion of VFA was greater for the dried orange pulp treatment. These results agree with those of Marounek *et al*. (1985). Romero and Molina, (2013) reported that diets including tomato and cucumber-based FB led to greater VFA concentration and decreased butyrate molar proportion in the rumen without affecting molar proportions of acetate, isovalerate, and valerate. Farzad and Rahim (2012) reported that concentration of total VFA profile in rumen fluid at 3 h post-feeding were used to observe the rumen fermentation pattern; concentration of VFA had increased with diets containing tomato and apple pomace. These trends are similar to those described by Rumsey (1978) and Chumpawadee and Pimpa (2009).

The production of NH_3-N (Table 6) was higher in the ration TP_{15} than rations C, TP_{10} and TP_{20} at 0 times, while there were no significant differences between diets after 2 and 6 h of feeding. Differences were significant ($P<0.05$) at 4 h between ration TP_{15} and TP_{20}. Ration OP_{15} was the highest in the production of NH_3-N at 0, 2 and 4 h. The difference between it and the control ration were significant ($P<0.05$). Ration TOP_{10} (containing corn silage with 5% orange pulp and 5% tomato pomace) was higher in the production of NH_3-N at 0 time but the differences between it and the other rations were not significant. After two hours of feeding, higher production of NH_3-N was found in the control ration. The ration TOP_{15} was the highest in the production of NH_3-N at 4 h; differences with rations C and TOP_{20} were significant. The control ration was the highest in the production of NH_3-N at 6 hr. But the differences between it and ration TOP_{10} and TOP_{15} were not significant.

The concentration of NH_3-N in the fermenters depends on the extent of CP degradation and N uptake by rumen bacteria (Ariza *et al*., 2001). The greater NH_3-N concentration found with the hominy feed treatment might have been related to a higher degradation of CP and lower carbohydrate fermentation compared with the dried orange pulp (Casper and Schingoethe, 1989). Reynolds *et al*. (1997) reported that rumen NH_3-N concentration was lower when cows were fed diets with rapidly fermented barley or dried whey than when diets were supplemented with corn as the energy substrate for rumen microbes. Farzad and Rahim (2012) found that rumen ammonia-N concentration were not different among diets containing different levels of tomato and apple pomace.

Blood parameters:

The highest value of total serum protein (Table 7) was found with ration TP_{15} (6.18g/dl), followed by ration TP_{10} (6.16g/dl); however, differences were not significant between the experimental rations. The highest value of albumin was for ration TP_{15}, which contained 15% tomato pomace; there were no significant differences between rations. The highest value of the globulin was reported for ration TP_{20}; differences were not significant between it and the other rations. There was no difference for A/G ratio in the diets containing tomato pomace. Diets contained the orange pulp recorded the highest value of total serum protein for ration OP_{10}, there was a significant difference between it and ration OP_{20} ($P<0.05$), while there was no significant difference regarding albumin. Globulin was higher for the control diet followed by diet OP_{10} containing 10% orange pulp; there was no significant difference between them, but differences between them and diets OP_{15} and OP_{20} were significant ($P<0.05$). No differences were reported for total protein between rations that contained both of tomato pomace and orange pulp. The highest value of albumin reported with ration TOP_{10} and TOP_{15}; the differences between them and rations TOP_{20} and control was significant. The highest value of globulin was found for the control ration, followed by ration TOP_{20} then TOP_{10}; differences were not significant. Differences were significant between them and the ration TOP_{15}.

Table 6: Rumen ammonia-N (mg/dl) in sheep as affected by dietary treatments

Sampling Time	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.
0 hr	C	13.89^{b}±0.38	0.05	C	14.19^{c}±0.43	0.01	C	14.52±0.42	NS
	TP_{10}	14.74^{ab}±0.39		OP_{10}	15.89^{ab}±0.44		TOP_{10}	15.03±0.39	
	TP_{15}	15.59^{a}±0.36		OP_{15}	16.49^{a}±0.41		TOP_{15}	14.93±0.43	
	TP_{20}	14.46^{ab}±0.38		OP_{20}	14.96^{bc}±0.42		TOP_{20}	14.50±0.44	
2 hr	C	16.36±0.47	NS	C	16.64^{c}±0.57	0.01	C	17.12^{a}±0.54	0.05
	TP_{10}	17.39±0.38		OP_{10}	18.64^{ab}±0.58		TOP_{10}	16.92^{a}±0.52	
	TP_{15}	17.66±0.48		OP_{15}	19.43^{a}±0.56		TOP_{15}	17.04^{a}±0.39	
	TP_{20}	16.33±0.48		OP_{20}	17.67^{bc}±0.51		TOP_{20}	14.93^{b}±0.48	
4 hr	C	18.35^{ab}±0.53	0.05	C	18.20^{c}±0.64	0.01	C	18.42^{b}±0.48	0.05
	TP_{10}	19.20^{a}±0.5		OP_{10}	20.89^{ab}±0.59		TOP_{10}	19.39^{ab}±0.46	
	TP_{15}	19.89^{a}±0.54		OP_{15}	21.79^{a}±0.58		TOP_{15}	20.48^{a}±0.48	
	TP_{20}	17.47^{b}±0.49		OP_{20}	19.28^{bc}±0.62		TOP_{20}	18.40^{b}±0.49	
6 hr	C	15.88±0.56	NS	C	17.27^{ab}±0.70	0.05	C	17.54^{a}±0.63	0.05
	TP_{10}	15.51±0.52		OP_{10}	19.19^{a}±0.65		TOP_{10}	16.14^{ab}±0.65	
	TP_{15}	16.51±0.55		OP_{15}	19.03^{a}±0.68		TOP_{15}	15.96^{ab}±0.61	
	TP_{20}	15.20±0.57		OP_{20}	16.68^{b}±0.67		TOP_{20}	15.27^{b}±0.67	

C, corn silage; TP_{10}, C+10% TP; TP_{15}, C+15% TP; TP_{20}, C+20% TP; OP_{10}, C+10% OP; OP_{15}, C+15% OP; OP_{20}, C+20% OP; TOP_{10}, C+5%TP+5%OP; TCP_{15}, C+7.5%TP+7.5%OP; TOP_{20}, C+10%TP+10%OP.

Table 7: Blood parameters of sheep as affected by dietary treatments

Item	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.	Rations	Mean±SE	Sig.
Total Protein, g/dl	C	6.14±0.02	NS	C	6.16^{ab}±0.02	0.05	C	6.19±0.02	NS
	TP_{10}	6.16±0.02		OP_{10}	6.20^{a}±0.03		TOP_{10}	6.19±0.01	
	TP_{15}	6.18±0.01		OP_{15}	6.13^{ab}±0.02		TOP_{15}	6.18±0.02	
	TP_{20}	6.15±0.02		OP_{20}	6.12^{b}±0.04		TOP_{20}	6.15±0.03	
Albumin (A), g/dl	C	4.09±0.04	NS	C	4.06±0.02	NS	C	4.08^{b}±0.02	0.05
	TP_{10}	4.05±0.03		OP_{10}	4.12±0.01		TOP_{10}	4.14^{a}±0.01	
	TP_{15}	4.06±0.04		OP_{15}	4.12±0.02		TOP_{15}	4.14^{a}±0.01	
	TP_{20}	4.02±0.02		OP_{20}	4.11±0.03		TOP_{20}	4.08^{b}±0.02	
Globulin (G), g/dl	C	2.04±0.05	NS	C	2.10^{a}±0.02	0.05	C	2.12^{a}±0.02	0.05
	TP_{10}	2.10±0.03		OP_{10}	2.09^{a}±0.01		TOP_{10}	2.06^{ab}±0.01	
	TP_{15}	2.12±0.02		OP_{15}	2.00^{b}±0.01		TOP_{15}	2.04^{b}±0.03	
	TP_{20}	2.14±0.05		OP_{20}	2.00^{b}±0.02		TOP_{20}	2.07^{ab}±0.02	
A:G ratio	C	2.03±0.06	NS	C	1.94^{b}±0.02	0.05	C	1.93^{b}±0.03	0.05
	TP_{10}	1.94±0.05		OP_{10}	1.97^{b}±0.03		TOP_{10}	2.02^{ab}±0.05	
	TP_{15}	1.93±0.06		OP_{15}	2.06^{a}±0.04		TOP_{15}	2.03^{a}±0.03	
	TP_{20}	1.90±0.04		OP_{20}	2.06^{a}±0.03		TOP_{20}	1.98^{ab}±0.04	
GOT(U/L)	C	18.97±0.05	NS	C	18.92±0.05	NS	C	19.00±0.06	NS
	TP_{10}	19.00±0.04		OP_{10}	18.96±0.03		TOP_{10}	19.10±0.09	
	TP_{15}	19.10±0.06		OP_{15}	18.94±0.06		TOP_{15}	19.12±0.08	
	TP_{20}	19.11±0.04		OP_{20}	18.99±0.07		TOP_{20}	18.99±0.09	
GPT(U/L)	C	31.08±0.05	NS	C	30.98±0.04	NS	C	31.07±0.09	NS
	TP_{10}	31.11±0.06		OP_{10}	30.99±0.06		TOP_{10}	31.12±0.08	
	TP_{15}	31.00±0.08		OP_{15}	31.01±0.08		TOP_{15}	30.98±0.08	
	TP_{20}	31.14±0.07		OP_{20}	31.10±0.08		TOP_{20}	31.14±0.0.9	

C, corn silage; TP_{10}, C+10% TP; TP_{15}, C+15% TP; TP_{20}, C+20% TP; OP_{10}, C+10% OP; OP_{15}, C+15% OP; OP_{20}, C+20% OP; TOP_{10}, C+5%TP+5%OP; TCP_{15}, C+7.5%TP+7.5%OP; TOP_{20}, C+10%TP+10%OP.

Generally, the obtained values of the blood parameters were within the normal ranges. Abdel Gawad *et al*. (2013) reported insignificant differences among blood metabolites concentration (total protein, urea, creatinine, triglycerides) of all bulls groups fed rations containing levels of orange pulp. These results are in agreement with finding of Belibasakis and Tsirgogianni (1996), Osman *et al*. (2014) reported that plasma concentrations of cholesterol and total protein did not significantly differ between the experimental diets containing different levels of ensiled apple pomace.

It could be concluded from the present work that tomato pomace and/or orange pulp could be used safely in corn silage making for ruminant feeding up to 20% without any adverse effect on digestion, rumen fermentation or blood serum proteins.

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استخدام تفل الطماطم والبرتقال فى عمل سيلاج الذرة لتغذية الحيوان

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الملخص العربى

أجريت هذه الدراسة لعمل سيلاج من الأذرة بدون كيزان مع مستويات مختلفة من تفل الطماطم والبرتقال حيث تم دراسة جودة السيلاج الناتج وكذلك تأثيره على معاملات الهضم والقيمة الغذائية والنشاط الميكروبى للكرش وكذلك تأثيره على بعض قياسات الدم فى الأغنام الأوسيمى فى تصميم تجريبى 4×4 المربع اللاتينى وقد اتضح ان اضافة تفل الطماطم والبرتقال عند عمل السيلاج من الأذرة بدون كيزان أعطى خواص جيدة للسيلاج حتى مستوى 20% حيث كانت حموضة السيلاج جيدة وكذلك اتضح من نتائج التجربة ان معاملات هضم البروتين الخام , الألياف الخام, المستخلص الخالى من النيتروجين ، مستخلص الايثير زادت عند التغذية على السيلاج الذى يحتوى على 10% تفل طماطم وكذلك زادت القيمة الغذائية مقدرة فى صورة مركبات كلية مهضومة وبروتين خام مهضوم عند هذا المستوى. وارتفعت ايضا معاملات هضم المادة الجافة ، البروتين الخام ، المستخلص الخالى من النيتروجين للعليقة التى تحتوى على سيلاج به 10% تفل برتقال بينما زاد معامل هضم الألياف الخام , مستخلص الايثير بصورة معنوية جدا فى العليقة التى تحتوى على سيلاج به 15% تفل برتقال. كذلك ارتفعت معاملات الهضم لكل من المادة الجافة , البروتين الخام , المستخلص الخالى من النيتروجين ، مستخلص الايثير فى العليقة المحتوية على سيلاج به 10% تفل طماطم وبرتقال. بينما زاد معامل هضم الألياف الخام فى العليقة التى تحتوى على سيلاج به 15% تفل طماطم وبرتقال. كذلك ادت التغذية على سيلاج الطماطم والبرتقال الى تحسن فى النشاط الميكروبى فى الكرش مقدرا فى صورة أحماض دهنية طيارة وانتاج امونيا عند المستويات 10% , 15% لسيلاج الطماطم والبرتقال . كانت قياسات الدم المأخوذة فى الحدود الطبيعية.