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Influence of Treated Orange Pulp on Growth Performance, Nutrients Digestibility and Plasma Constituents of Rabbits

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ABSTRACT

The current study investigated the effect of replacement of Untreated Orange Pulp (UOP) and Treated Orange Pulp (TOP) protein by basal diet protein on growth performance, digestion coefficients, some blood constitute of rabbits and economic efficiency of growing rabbit diets. Sixty cross bread (New Zealand White, NZW X California), six weeks of age with live body weight ranging from 729.20 to 738.30g were divided to five experimental groups. The experimental diets were T1, control diet without OP; T2, 5%UOP; T3, 5% TOP; T4, 10%UOP and T5, 10%TOP. The results indicated that TOP by *Saccharomyces cerevisiae* yeast increased content of the crude protein (%) and digestible energy (Kcal/kg). The best Final Body Weight (FBW, g), Body Weight Gain (BWG, g/R/day) and feed conversion ratio recorded in 5%TOP group. Digestion coefficient of Crude Protein and Digestible Crude Protein (DCP%) were significantly ($P<0.05$) increased in rabbits fed low replacement level of OP (5% UOP and 5%TOP). Total lipid of plasma was significantly differences ($P<0.05$) in groups fed experimental diets compared to control group. Liver function was significantly affected by experimental diets, yeast treatment and replacement level of OP. Best economic efficiency observed with 10%UOP followed by 5%TOP. It was concluded that rabbit group fed 5%TOP recorded a better performance, best digestibility for CP%, DCP and economic efficiency. *Saccharomyces cerevisiae* yeast treatment didn't effect on digestibility and nutritive value of growing rabbits.

Key words: Digestibility, Economic, Growing rabbits, Performance, Plasma, Yeast.

INTRODUCTION

Nutrition accounts for 70% of the total cost of rabbit or animal production (Oyawoye and Nelson, 1999; Spring, 2013). Incorporation of fruits and vegetable wastes in animal feeds improved palatability of diet and consequently increased the feed intake in addition to decrease feed cost (Chaudry et al., 2004 and Alnaimy et al., 2017). Sun dried orange peel meal and citrus pulp has been used as untraditional calorie and protein source in broiler diets (Oluremi et al., 2006; De Bals et al., 2018). Hon et al. (2009) concluded that sweet orange pulp meal could be utilized up to 20% of growing rabbit diets without any adverse effects on performance. Wang et al. (2017) found that using citrus pulp in geese diets less than 12% had no negative effects on growth performance and carcass traits.

Probiotics are live microorganisms used in animal diets as feed supplementation to enhance of the intestinal microbial balance (Fortun-Lamothe and Boullier, 2007). The use of probiotics in farm animal diets is based on the concept that the balance of intestinal microorganisms in healthy animals increases resistance to diseases, and it is necessary for efficient digestion and maximum absorption of nutrients. Some characteristics of probiotics are reported by Strompfova et al. (2006) which included the ability to reduce antibiotic use, high index of safety and natural or alternative therapies. The *Saccharomyces cerevisiae* is a probiotic and a possible using in animal diets because of its availability, safety and cheapness. Its cells contain a lot of proteins, carbohydrates, lipids, vitamins and minerals (Reddy et al., 2006). *S. cerevisiae* is a valuable and qualitative growth promoter for feeding livestock (Falcão-e-Cunha et al., 2007) and positive effects on Japanese quails performance (Nikpiran et al., 2013). So, present study aimed to investigate the effect of replacement of Untreated Orange Pulp (UOP) and Treated Orange Pulp (TOP) protein by basal diet protein on performance, digestion coefficients of nutrients, blood constitute of growing rabbits and economic efficiency of rabbit diets.

MATERIALS AND METHODS

The experiment was conducted in Borg El-Arab station following to Animal Production Research Institute (APRI), agricultural research center, ministry of agriculture and land reclamation, Egypt. The laboratories works were carried out at laboratories of

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utilization of by-products research department, APRI, Giza, Egypt. Dried orange pulp and other ingredients obtained from by-product of food industries and locally market. The dried yeast purchased from three pyramids Alexandria yeast Company, Alexandria, Egypt. Feed mixing and pelleting processes were carried out at Nobaria manufactory, Nobaria station following to APRI, Egypt.

Ethical approval

This study was carried out after obtaining the ethical approval of the APRI, Egypt (Code No 12-2-16).

Yeast treatment and experimental diets

Orange Pulp (OP) was mixed with water at 1:2 ratio (1pulp:2 water) to supply relative humidity of 85%. The measured pH value was 3.6. The optimum pH for yeast activity is between 5 and 6. Therefore, 6.4% bicarbonate was added to mixture to increase the pH value. Then added 4% dried yeast (*S. cerevisiae*) according to Dadvar et al. (2014). Five experimental diets were formulated, control diet without dried orange pulp and the other experimental diets were replacement of two levels of UOP or TOP (*S.cerevisiae*) protein by control diet protein. The experimental diets were divided into basal diet without OP as a control group (T_1), while 5% UOP (T_2), 5% TOP (T_3), 10% UOP (T_4) and 10% TOP (T_5) were different levels of UOP and TOP by *S. cerevisiae* yeast. The diets and fresh water were supplied *ad libitum.* The experimental period lasted for eight weeks from 6 to 14 weeks of age. All experimental diets (Table 1) were formulated to be isonitrogenous and isocaloric, to meet all the essential nutrients requirements of growing rabbits (Lebas, 2004).

Table 1. Ingredients and chemical composition of experimental diets in growing rabbits

Ingredients	Control diet	Replacement Level of OP protein (%)			
		5% UOP	5% TOP	10% UOP	10% TOP
Soybean meal (44% crude protein)	16.30	16.30	16.30	16.30	16.30
Yellow corn	13.80	11.8	11.35	9.75	10.90
Barley	13.00	13.00	13.00	13.00	13.00
Wheat bran	16.85	16.85	16.85	16.85	16.85
Clover hay	34.00	27.97	30.00	22.00	23.99
Untreated orange pulp (UOP)	00.00	8.03	00.00	16.05	00.00
Treated orange pulp (TOP)	00.00	00.00	6.45	00.00	12.91
Dl- methionine	0.20	0.20	0.20	0.20	0.20
Di calcium phosphate	2.00	2.00	2.00	2.00	2.00
Sodium chloride (NaCl)	0.35	0.35	0.35	0.35	0.35
Vitamin and mineral primix[1]	0.30	0.30	0.30	0.30	0.30
Anti coccidia and fungi	0.20	0.20	0.20	0.20	0.20
Molasses	3.00	3.00	3.00	3.00	3.00
Total	100.00	100.00	100.00	100.00	100.00
Chemical analysis (DM basis)					
DM%	82.94	82.96	82.37	82.98	82.98
OM%	85.76	85.23	85.38	84.71	84.88
CP%	17.49	17.30	17.55	17.12	17.51
CF%	13.88	13.28	13.60	12.70	12.74
EE%	2.17	2.29	2.25	2.45	2.37
NFE%	55.43	55.64	55.14	55.83	55.59
Ash%	5.09	5.53	5.53	5.98	5.86
DE kcal/kg[2]	2615.42	2628.44	2610.37	2640.38	2642.64
Price of feed (L.E./ton)	4927.18	4721.67	4756.58	4516.00	4601.73

[1]Each kg of vitamins and minerals mixture contains: Vit. A: 2.000.000 IU, Vit.B1: 0.33g, Vit.B2: 1.0g, Vit.D3: 150.000 IU, Vit E: 8.33g, Vit. K: 0.33 g, Pantothenic acid: 3.33g, Nicotinic acid: 30.00g, Vit. B6: 2.00g, Vit. B12: 1.7 mg, Folic acid: 0.83g, Biotin: 33 mg, Cu: 0.5g, choline choloride: 200mg, Mn: 5.0g, Fe: 12.5g, Mg: 66.7mg, Co: 1.33 mg, Se: 16.6 mg, Zn: 11.7 Iodine: 16.6 mg and Anti-oxidant: 10.0g, [2]DE= Digestible energy (kcal/kg) = 4.36-0.049 × [28.924 + 0.657 (CF%)] according to Cheeke, (1987), UOP: untreated orange pulp, TOP: treated orange pulp.

Experimental animals and housing

Sixty cross breed (New Zealand White, NZW X California), six weeks of age with live body weight ranging from 729.20 to 738.30 g were divided to five experimental groups (12 rabbits in each). All rabbits were kept under the same managerial and hygienic conditions and housed in metal battery cages supplied with separated feeders. All rabbits were kept under veterinary control and vaccinated against diseases; SERVAC RHDV oil vaccine and SERVAC Formalized polyvalent Rabbit Pasteurellosis Vaccine. All vaccines had purchased from Veterinary Serum and Vaccine Research Institute, Elabasia, Cairo, Egypt.

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Productive performance

Final body weight, daily feed intake (FI, g/rabbit/day) and daily body weight gain (BWG, g/rabbit/day) were recorded weekly, feed conversion ratio (FCR) was calculated accordingly as g feed / g gain over an experimental period.

Digestion coefficients and nutritive value

Fifteen rabbits were used in digestion trial and divided to five groups (three replicates/each). Rabbits were housed in individual metabolism cages (56 × 38 × 28 cm, L × W × H). Feces were collected daily before the morning meal and weighed fresh and dried at 60 °C for 24 h in an air drying oven (Perenz et al., 1995). Samples of UOP and TOP, diets and feces were prepared to determine moisture, ash, nitrogen, ether extract and crude fiber according to AOAC (2000). Data of quantities and chemical analysis of feed and feces were used to nutrients digestibility and nutritive value calculation for each dietary treatment (Fekete, 1985). Digestible energy (DE, Kcal/Kg diet) was calculated as follow: Total Digestible Nutrient (TDN) × 44.3 according to Schneider and Flatt (1975).

Biochemical analysis

Blood samples of all 15 rabbits were collected (3 rabbits/treatment randomly selected) into dry clean centrifuge tubes and centrifuged at 3000 rpm for 20 minutes, then, samples were transferred and stored in deep freezer at -20°C till the time of analyses. Blood chemical analyses were carried out for determination of plasma total lipids (Frings and Dunn, 1970), triglycerides, cholesterol, creatinine and urea nitrogen (Young, 2000), Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT) were determined by Henry (1964). All kits had purchased from Bio-dignostic, diagnostic and research reagents company, Dokki, Giza, Egypt. All plasma biochemical analyses were determined spectrophotometrically at 546 nm using colorimetric kits.

Economic efficiency

The Economic Efficiency (EEF) was calculated according to the following equation:

EEF (%) = (Net revenue/ total feed cost) × 100. Whereas, Net revenue =Selling price/rabbit- total feed cost/rabbit.

The price of ingredients and selling of one kg live weight of rabbits as the same price in the local market at the time of experiment (October, 2018). Price of one kg live body weight was 50 LE (1 LE = 17.32 $).

Statistical analysis

Data were analyzed using general linear model procedure of SAS software (SAS, 2004) by using model: $Yij = \mu + L_i + S_j + (LS)_{ij} + e_{ij}$ Where, Y_{ij} = an observation; μ = overall mean; L_i = effect of OP substitution levels; S_j= the effect of *S.cerevisiae* yeast treatment, $(LS)_{ij}$= effect of interaction between OP substitution levels with yeast treatment and e_{ij} = random error. Duncan's multiple range test (Duncan, 1955) was performed to detected significant differences among means. Significant level was acceptable at $P \leq 0.05$.

RESULTS AND DISCUSSION

Chemical composition of UOP and TOP

Table 2 is summarized the chemical composition of OP before and after treated by *S. cerevisiae* yeast. Percentage of the Dry Matter (DM), Organic Matter (OM), Crude Fiber (CF), Ether Extract (EE) and Nitrogen Free Extract (NFE) content decreased in TOP when compared to UOP. In contrast, Crude Protein (CP%) (13.17 vs. 10.59%), ash and Digestible Energy (DE, kcal/kg) were higher in TOP than UOP. The obtained results are in agreement with Dadvar et al. (2015) reported treated lemon pulp with *S. cerevisiae* yeast up to 4% increased CP% content of lemon pulp. Also, treated castor meal by *Penicillium funiculosm* caused increase in CP%, DE, Kcal/kg and ash% content while, decreased in DM%, OM%, CF% and NFE% (Suliman et al., 2015). The biological treatment is used for increasing the nutritional value of many by-products because they had significant concentrations of simple carbohydrates such as mono and disaccharides (Villas-Boas et al., 2002). Moreover, increasing ash content attributed to the growth or degradation of organic matter by microorganism. While, reducing CF and NFE contents were due to microorganisms which depend on carbohydrates consumption as energy sources for growth, the microbial protein formation, and multiplication (Abdel-Aziz et al., 2015; Suliman et al., 2015).

Table 2. Chemical composition of untreated and treated orange pulp by *Saccharomyces cerevisiae* yeast

Items	DM%	OM%	CP%	CF%	EE%	Ash%	NFE%	DEkcal/kg*
Untreated orange pulp (UOP)	87.84	88.50	10.59	15.53	3.87	11.50	58.52	2442.77
Treated orange pulp (TOP)	78.95	87.93	13.17	14.83	3.67	12.07	56.25	2465.3

DM: dry matter, OM: orange matter, CP: crude protein, CF: crude fiber. EE: ether extract, NFE: nitrogen free extract. *Digestible energy (kcal/kg) = 4.36-0.049 × [28.924 + 0.657 (CF%)] according to Cheeke, (1987)

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Growth performance

Influence of several levels of UOP or TOP on growing rabbits performance is shown in table 3. The FBW (g) of growing rabbits didn't significantly effect by the yeast treatment, replacement level of OP and their interaction. Rabbits fed 10% UOP were significantly ($p<0.05$) decreased in daily BWG when compared with other groups while, group fed 5% UOP did not affected significantly. The BWG was significantly ($p<0.05$) affected by yeast treatment while, OP different levels did not appear any significant effect. The rabbit groups fed 5% UOP, TOP and 10% TOP significantly ($p<0.05$) consumed more daily feed than control and 10%UOP groups. Moreover, effect of the yeast treatment and OP replacement levels consumed significantly ($p<0.05$) FI. FCR significantly ($p<0.05$) improved in 5% TOP group compared to other groups except control and 10% TOP groups that weren't significantly different. The effects of yeast treatment and OP replacement levels did not cause significant differences. The results were in partial agreement with findings of Suliman and Ameen, (2018) who observed no significantly difference in FBW, BWG, FI and FCR among experimental rabbits groups fed lemon pulp treated by *S.cerevisiae* yeast. The FI increased probably due to increase in palatability of dietary orange pulp. This result conformed by Rizal et al. (2010) were found that adding up to 20% of juice wastes mixture (carrot, apple, mango, orange, melon and tree tomato) in broiler diets, increased the amount of feed consumption. The improvement of FI by yeast treatment confirmed by Shehu et al. (2014) who found intake of growing rabbits increased ($p<0.05$) in rabbits fed diets supplemented 60g/kg *S. cerevisiae* yeast. On the contrary, FI, BWG and FCR of growing rabbits didn't affect by the dietary citrus pulp (Lu et al., 2018) and yeast supplementation (Belhassen et al., 2016). The DM intake of growing rabbits recorded did not significantly affected by yeast supplementation (Khanna et al., 2014).

Table 3. Growth performance of rabbits (6-14 weeks of age) fed on different levels of orange pulp untreated and treated by *Saccharomyces cerevisiae* yeast

Items	Control diet	Replacement Level of OP protein (%)				P-value		
		5%		10%				
		Untreated	Treated	Untreated	Treated	L × Y effect	Yeast effect	Level effect
IBW (g)	730.8±83.78	738.3±90.07	731.7±86.25	738.3±88.93	729.2±84.07	1.00	0.94	0.99
FBW (g)	2063.3±64.14	1978.3±117	2125.8±155.44	1865.0±93.28	2040.0±123.28	0.57	0.27	0.61
BWG (g/R/day)	23.38^{a}±1.16	21.75^{ab}±0.97	24.46^{a}±1.40	19.77^{b}±0.29	23.00^{a}±0.69	0.02	0.03	0.21
FI (g/R/day)	95.89^{b}±1.92	104.11^{a}±2.04	103.30^{a}±2.21	95.92^{b}±1.06	101.92^{a}±1.53	0.004	0.04	0.005
FCR (Feed:gain)*	4.14^{b}±0.14	4.84^{a}±0.26	4.28^{b}±0.21	4.86^{a}±0.07	4.45^{ab}±0.14	0.02	0.19	0.10

[a and b] means (mean± SE) within the same row with common letter are not significantly different ($P>0.05$). *Feed conversion ratio (FCR): g feed/g gain. OP: Orange Pulp, L x Y effect: statistical effect of interaction between level of orange pulp and yeast treatment effect on measurement parameters, Yeast effect: statistical effect of yeast only on measurement parameters, Level effect: statistical effect of replacement levels of OP only on measurement parameters.

Digestion coefficient of nutrients and nutritive value

Table 4 indicated the effect of several experimental diets on nutrients digestion coefficients and nutritive value of growing rabbits. The percentages of DM and OM did not have significant differences among all experimental groups except the group fed 5% UOP that was significantly ($P<0.05$) increased. While, the yeast treatment and OP replacement levels did not significantly effect on DM% and OM% values. The CP% was significantly ($p<0.05$) increased in rabbit fed 5% UOP and TOP diets when compared to other rabbits. The replacement levels of OP were significantly ($p<0.0001$) effect on CP% digestibility, while the yeast treatment did not cause a significant change. No significant differences were recorded in digestion coefficient of CF among different groups except group fed 5%UOP diet which was significantly ($p<0.05$) increased. The replacement levels of OP revealed significantly ($p< 0.02$) effect on CF digestibility but no significant effect due to yeast treatment was seen. The EE and NFE digestibility did not cause significantly differences among all rabbit groups. So, the yeast treatment and levels of replacement of OP didn't significantly effect on digestibility of EE and NFE. Santos et al. (2014) found that the inclusion of citrus pulp in the daily feed of lactating cow improved the apparent digestibility of DM, CP, EE and non-fibrous carbohydrates. However, rabbits fed diet supplemented with 60g *S. cerevisiae*/kg had higher ($p<0.05$) digestibility of nutrients than those fed diets supplemented with 20, 40 and 80g/kg (Shehu et al., 2014).

The highest significant value ($p<0.05$) of Digestible Crude Protein (DCP%) recoded in rabbits fed 5% UOP and TOP diets compared to control,10% UOP and 10% TOP groups. However, the group fed 10% TOP recorded the lowest significant ($p<0.05$) value of DCP when compared to all rabbits fed other diets. Yeast treatment didn't cause significantly difference in DCP% but the OP replacement levels had significant ($p<0.05$) effect on DCP%. The differences in values of TDN and DE were not significantly

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among all experimental rabbits. Also, the yeast treatment and replacement levels of OP didn't affect in TDN and DE values. Generally, feeding dietary OP treated by yeast significantly ($p<0.05$) improved some digestion coefficients of nutrients and DCP%. This improvement in digestion of nutrients reported by Ibrahim et al. (2011) who found that digestion coefficients of nutrients improved in rabbits fed 20% and 60% OP. In present study, the yeast treatment did not effect in all nutrients digestibility and nutritive value however the replacement levels of OP recoded significantly ($p<0.0001$) differences in digestion coefficient of CP% and DCP%.

Table 4. Digestion coefficients and nutritive value of growing rabbits (6-14 weeks of age) fed on different levels of orange pulp untreated and treated by by *Saccharomyces cerevisiae* yeast

Items		Control diet	Replacement level of OP protein (%)				P-value		
			5%		10%				
			Untreated	Treated	Untreated	Treated	L ×Y effect	Yeast effect	Level effect
Digestion coefficients (%)	DM	59.54^{b}±0.614	64.85^{a}±1.65	59.69^{b}±0.36	58.44^{b}±2.06	59.25^{b}±0.84	0.03	0.37	0.12
	OM	64.73^{b}±0.43	69.79^{a}±1.44	65.87^{b}±0.29	65.55^{b}±1.79	65.56^{b}±0.66	0.04	0.46	0.12
	CP	62.50^{b}±0.48	70.12^{a}±1.43	70.34^{a}±0.25	61.08^{b}±2.04	60.37^{b}±1.53	0.001	0.77	<0.0001
	CF	31.49^{b}±0.67	41.76^{a}±2.89	33.05^{b}±0.53	30.76^{b}±3.48	25.59^{b}±1.77	0.006	0.11	0.02
	EE	71.20±3.58	72.66±3.78	74.69±2.21	74.66±3.01	75.88±2.24	0.81	0.35	0.51
	NFE	71.89±4.29	75.86±3.19	71.78±3.30	72.93±5.25	74.94±5.15	0.94	0.95	0.90
Nutritive value	DCP %	10.93^{b}±0.08	12.13^{a}±0.24	12.34^{a}±0.04	10.19^{c}±0.34	8.82^{d}±0.19	<0.0001	0.51	<0.0001
	TDN %	58.63±2.41	63.67±2.18	60.20±2.01	58.93±3.86	57.79±3.04	0.61	0.58	0.38
	DE Kcal/kg	2597.50±106.79	2820.40±96.58	2667.00±89.39	2610.40±171.21	2560.10±134.87	0.61	0.58	0.38

$^{a \text{ and } b}$ means (mean± SE) within the same row with common letter are not significantly different ($p>0.05$). OP: orange pulp, DM: dry matter, OM: organic matter, CP: crude protein, CF: crude fiber, EE: ether extract, NFE: nitrogen free extract, DCP: digestible crude protein, TDN: total digestible nutrients, DE: digestible energy=TDN x 44.3 (Schneider and Flatt, 1975): L x Y effect: statistical effect of interaction between level of orange pulp and yeast treatment effect on measurement parameters, Yeast effect: statistical effect of yeast only on measurement parameters, Level effect: statistical effect of replacement levels of OP only on measurement parameters.

Plasma parameters

Some plasma parameters of growing rabbits fed diets contained levels of UOP or TOP are presented in table 5. All values of blood biochemistry were within the physiological ranges. Total Lipids (TL) of rabbits plasma blood was significantly ($p<0.05$) increased among all rabbits fed four experimental diets when compared to those fed control diet. Two levels of OP caused significant ($p<0.05$) changes on TL but the yeast treatment did not change significantly the TL. No significant differences were recorded among different experimental groups in plasma cholesterol and triglyceride. Also, the yeast treatment and levels of OP did not obtained a significant ($p>0.05$) effect on plasma cholesterol and triglyceride values except yeast treatment that caused significant ($p<0.05$) difference in plasma triglyceride. Both AST and ALT had significantly ($p<0.05$) differences among all experimental groups except group fed 5%UOP diet did not cause significant different level of ALT when compared to control group. Yeast treatment and replacement levels of OP were significantly ($p<0.05$) affect the liver function. The plasma creatinine didn't effect by OP replacement level, yeast treatment or their interaction. However, plasma urea had significantly ($p<0.05$) changes. These results confirmed by Solomon et al. (2015) that observed significant differences in AST and ALT levels in rabbit blood when feed diets containing 25, 50 and 75% fresh citrus lemon juice. Suliman and Ameen (2018) who found that total lipids, cholesterol, triglycerides, AST, ALT and urea had significant ($p<0.05$) difference among all rabbit groups fed lemon pulp treated by yeast when compared to control group. However, Jingzhi et al. (2018) found that AST did not significantly change in rabbits at 21% citrus pulp. Generally, the experimental diets were significantly different ($p<0.05$) in some blood parameters among rabbit fed dietary containing 5% and 10% OP treated by *S. cerevisiae* yeast. Also, yeast treatment and replacement levels of OP caused significant effect on some blood parameters of growing rabbits.

Economic efficiency

The effect of test diets on profit and economic efficiency is presented in table 6. It is clear that experimental rabbit group fed 10% TOP diet had lowest total feed cost/rabbit followed by 10% UOP and control group. While, better economic efficiency observed with rabbits fed 10% UOP followed by 5% TOP when compared to the rabbit groups fed other experimental diets include control group.

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Table 5. Blood constituents of growing rabbits (6-14 weeks of age) fed on different levels of orange pulp untreated and treated by by *Saccharomyces cerevisiae* yeast

Items	Control diet	Replacement Level of OP protein (%)				P-value		
		5%		10%				
		Untreated	Treated	Untreated	Treated	L × Y effect	Yeast effect	Level effect
Total lipid (mg/dl)	1.36^{e}±0.005	2.465^{a}±0.03	2.340^{b}±0.017	2.225^{c}±0.02	2.075^{d}±0.037	<.0001	0.38	<.0001
Cholesterol (mg/dl)	130.87±16.83	175.33±35.97	138.67±1.45	121.00±13.05	134.00±1.154	0.35	0.74	0.29
Triglyceride mg/dl)	280.63±32.24	273.00±51.25	196.00±20.428	271.00±43.15	166.00±15.874	0.13	0.006	0.49
AST (U/l)	38.76^{b}±1.657	58.01^{a}±3.15	18.70^{c}±2.44	13.26^{cd}±1.64	10.12^{d}±1.085	<.0001	0.01	0.01
ALT(U/l)	32.91^{a}±1.74	32.75^{a}±1.46	15.73^{b}±1.89	20.59^{b}±5.95	17.11^{b}±1.70	0.004	0.004	0.007
Creatinine (mg/dl)	1.58±0.48	1.20±0.06	1.63±0.025	1.09±0.25	1.58±0.075	0.44	0.17	0.75
Urea (mg/dl)	53.66^{c}±3.425	79.77^{bc}±7.95	113.27^{a}±15.54	76.87^{bc}±1.09	86.13^{b}±0.669	0.005	0.008	0.01

[a, b and c] means (mean± SE) within the same row with common letter are not significantly different (p>0.05). OP: Orange Pulp, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, L x Y effect: statistical effect of interaction between level of orange pulp and yeast treatment effect on measurement parameters, Yeast effect: statistical effect of yeast only on measurement parameters, Level effect: statistical effect of replacement levels of Orange Pulp only on measurement parameters.

Table 6. Economic efficiency of experimental diets of growing rabbits on October, 2018 in Egypt

Items	Control	5% UOP	5% TOP	10% UOP	10% TOP
Total body weight gain (kg)	1.33	1.24	1.39	1.31	1.12
Price of 1 kg body weight (LE*)	50	50	50	50	50
Selling price/rabbit (L.E.) (A)	66.63	62	69.71	65.54	56.33
Total feed intake (kg)	5.46	5.93	5.89	5.81	5.47
Price of 1 kg feed (LE)	4.93	4.72	4.76	4.52	4.60
Total feed cost/rabbit (LE) (B)	26.93	28.02	28.01	26.23	25.16
Net revenue (LE)[1]	39.69	33.98	41.70	39.31	31.17
Economical efficiency[2]	147.39	121.28	148.88	149.83	123.90

UOP: untreated orange pulp, TOP: treated orange pulp, Net revenue[1]: A - B, Economical efficiency (%)[2]: (Net revenue / B) × 100. *LE: 17.32$.

CONCLUSION

Treated orange pulp by *S. cerevisiae* yeast increased the CP% and DE kcal/kg content. Replacing TOP protein by basal diet protein in growing rabbit diets at 5% improved performance and achieved the best economic efficiency. Digestion coefficient of CP% and DCP% increased with 5% OP groups. However, yeast treatment didn't effect on digestible nutrients.

DECLARATIONS

Author's contributions

Dr. Marwa A. Suliman designed the work, collaborated the chemical analyses and drafted the manuscript. Dr Reham R. Eltanani performed the statistical analysis, tabulation of the experimental data and helped in blood analyses. Dr. Lamiaa Fathy Abdel-Mawla performed the practical part of the experiment and collaborated the chemical analyses.

Competing interests

The authors have declared that no competing interest exists.

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