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AN APPROACH TO REDUCE ENVIRONMENTAL POLLUTION AND PRODUCE CHEAPEAPEST MEAT FROM QUAILS BY USING OKARA MEAL AND SUPPLEMENTAL ENZYMES

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ABSTRACT

A total of 600 one day old Japanese quail chicks were used in this experiment to study the effect of using different levels of okara meal in quail diets growth performance, nutrients digestibility and economical efficiency as well as to reduce environmental pollution. Birds were distributed randomly and divided equally into 8 experimental groups with 3 replicates of 25 birds each. Okara meal was used as a substitution of soybean meal at levels of 0, 20, 40 and 60 %. Each either without or with prozyme supplementation at 0.5 kg/ ton. Therefore, the dietary treatments were distributed in a 4 X 2 factorial arrangement. All treatments containing okara meal were compared with control group, which was formulated without okara meal and enzyme supplementation. Birds were housed in battery cages under the same management conditions up to 7 weeks of age.

Results obtained indicated significant ($P<0.05$) improvement in the average values of CP and EE digestibility due to using okara meal at level of 20 % of soybean meal. While, adding prozyme to quail chick diets significantly ($P<0.05$) improved all nutrients digestibility. Data showed that the use of 20 % okara meal instead of soybean meal significantly ($P<0.05$) increased the average values of live body weight and weight gain. Also, supplemental prozyme to different levels of okara meal diets increased both live body weight and weight gain, decreased feed intake and improved feed conversion values. While, feeding quail chicks on diets containing graded levels of okara meal as replacing for soybean meal without enzyme supplementation increased feed intake values and recorded the worst feed conversion values compared to control group. Data showed that replacing okara meal for soybean meal at levels of 20, 40 or 60 %, with or without supplemental enzyme, decreased the total cost/kg live body weight and increased economical efficiency values compared to control group.

Therefore, it could be concluded that Japanese quail chicks could be fed diets containing different levels of okara meal up to 60 % as replacing for soybean meal either without or with supplemental enzyme without adverse effect on quail chick performance, nutrient digestibility and economical efficiency.

Keywords: Japanese quail ,Okara meal, enzyme, digestibility, growth performance

INTRODUCTION

Industry by-products is considered as pollutants for the environmental, so the using of these by-products in poultry feed are useful for solving either the pollution problems or the high feed cost. Feeding cost represents the major part of total cost in poultry production. Minimizing the feed cost could be achieved through the use of untraditional cheaper feed ingredients or improving utilization of common feeds by using some additives. Attention therefore should be drawn towards the use of some local by-products available in Egypt. For instance okara meal accumulated after

processing of soy milk that can cause environmental pollution. Okara is the residue left from ground soybean after extraction of the water extractable fraction used to produce soymilk and tofu (Desmond, 1999). About 1.1 kg of fresh okara is produced from every kg of soybean processed for soymilk (Khare *et al.,* 1995). In Japan, about 700000 tons of okara were produced from the tofu production industries in 1986, most of which was burnt as waste (Ohno *et al.,* 1993). Recently, in Egypt, there are some small industries produce soymilk, tofu, and other soy products, thus produce okara as waste. Compared to soybean meal, okara has less amount of crude protein, but both are nearly equal in protein quality. Therefore, okara meal is a possible optional feed ingredient for poultry. Some studies were conducted by Ma *et al.* (1996) and Frahat *et al.* (1998) to evaluate the use of okara in poultry feeding. They found that okara has a high quality protein for poultry feeding. They found also that using okara meal in a balanced diet did not affect on performance of Pekin or Muscovy ducklings.

Abd-Elsamee *et al.* (2005) showed that feed conversion values were insignificantly differ with using 20, 40 or 60 % okara meal as replacing for soybean meal in broiler chick diets. Also, Ibrahem (2006) found that it could be recommended to use okara meal up to 25% to replace soybean meal in broiler diets supplemented with phytase without adverse effects on growth performance, nutrients digestibility and production costs. In the other study conducted by El-Manylawi (2007) found that growing rabbits could be fed diets containing okara meal up to 25 or 50 % as replacing for soybean meal without adverse effects on growth performance.

On the other hand, some studies have shown in vitro, that phytate-protein complexes are insoluble and less subject to attack by proteolyses enzymes than the same protein alone (Ravindran *et al.,* 1999).The reduced solubility of protein as a result of such complexing can adversely affect certain properties of protein that are depend on their hydration and utilization. Therfore, dietary supplementation of microbial phytase would be expected to have protein/ amino acid effect in poultry feeding (Yi *et al..,*1996; Biehl and Baker,1997 and Ravinddran *et al.,*1999).

All these studies demonstrate generally positive effects of supplemental phytase on protein / amino acid digestibility and utilization in broilers.

The main target of this study was to evaluate the effect of the partial replacement of okara meal for soybean meal in quail diets supplemented or un-supplemented with prozyme on quail chick performance, nutrients digestibility and economic efficiency, as well as to reduce environmental pollution .

MATERIALS AND METHODS

The present work was conducted at Animal Production Department, Faculty of Environmental Agricultural Sciences, Al-Arish , North Sinai, Suez Canal University. A total number of 600 one day old Japanese quail chicks were assigned into 8 treatment groups. Each treatment contains three replicates, of 25 birds each. All the experimental chicks were housed in battery cages under the same management conditions. They were fed the experimental diets throughout 7 weeks experimental period.

Treatments and Diets:

The dietary treatments were distributed in a factorial experimental design (4 x 2), in which four levels of okara meal being 0, 20 , 40 and 60% and two levels of prozyme supplementation (0 and 0.5 kg/ton) were used. Prozyme is an enzyme mixture each kg contains 4.6g protease, 23g amylase, 75g celluase and 210g lipase, Prozyme products LTD., 6600N. Lincoln Avenue , 213, Lincolon wood , Illiois 60465, USA. The treatments were as follow:

T1: Basal diet (control)
T2:Control + 0.05% Prozyme
T3:20% Okara
T4:20% Okara + 0.05 % Prozyme
T5:40% Okara
T6: 40% Okara +0.05% Prozyme
T7: 60%Okara
T8: 60% Okara + 0.05% Prozyme

In the experimental treatments. Okara meal was incorporated at 20, 40 and 60% instead of dietary soybean meal. The chemical composition and amino acid composition of okara meal used in this study are listed in Table 1. Also, the composition of the experimental diets and their calculated analysis are shown in Table 2.

Table (1): Chemical composition of Okara meal and soybean meal (% on DM basis).

Item	Soybean meal	Okara meal
DM	89.06	95.05
CP	44.10	36.50
EE	1.51	11.40
CF	7.09	21.61
NFE	41.20	26.72
Ash	6.10	3.77
Ca	0.30	0.45
AV. P	0.29	0.46
Amino acids composition*		
Methionine	0.50	0.65
Lysine	2.30	2.92
Cystine	0.24	0.67
Arginine	1.16	3.25
Threonine	0.71	1.78
Valine	0.88	2.36
Histidine	0.50	1.14
Fiber fractionation :		
Acid detergent fiber (ADF)		36.88
Neutral detergent fiber (NDF)		61.32
Hemi-cellulose (HCS)		24.44
Cellulose (CLS)		29.63
Lignin (LGN)		7.25

Hemicelluloses = NDF - ADF
Cellulose = ADF - ADL
* According to *El-Manylawi* (2007).

Table (2): Composition and calculated analysis of experimental diets.

Ingredients	Levels of okara meal replacement of soybean meal			
	0 %	20 %	40 %	60 %
Yellow corn	51.50	50.00	48.60	47.50
Soybean meal (44%)	40.00	32.00	24.00	16.00
Okara meal (36.5%)	-	8.00	16.00	24.00
Corn gluten meal (60%)	3.40	4.50	5.80	6.90
Vegetable oil	2.00	2.30	2.40	2.40
Bone meal	2.00	2.00	2.00	2.00
Limestone	0.50	0.50	0.50	0.50
NaCl	0.30	0.30	0.30	0.30
Vit & Min. Premix*	0.30	0.30	0.30	0.30
L-lysine HCl	-	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Calculated analysis **				
CP %	24.17	24.16	24.17	24.13
ME (kcal/kg)	2920	2922	2913	2900
EE %	4.64	5.62	6.49	7.36
CF %	4.13	5.26	6.40	7.54
Methionine %	0.43	0.44	0.44	0.45
Lysine %	1.33	1.38	1.34	1.30
Calcium %	0.88	0.89	0.90	0.91
Av. Phosphorus %	0.42	0.43	0.45	0.48
Price / ton (LE)	1940	1870	1775	1670

* Supplied per kg of diet;Vit.A,12,000 IU; Vit D3, 2,000 IU ; Vit E , 40 mg ; Vit , K3 , 4 mg ; Vit B1, 3 mg ; Vit, B2, 6 mg; Vit, B6, 4 mg; Vit. B12, 30 mcg; Niac 30 mg; Folic Acid, 1.5 mg ;Biotin 80mcg ;Pantothenic Acid , 13.2 mg ; Choline Chloride, 700 mg ; Iron , 40 mg ; Copper , 10 mg ; Zinc , 70 mg ; Selenium , 0.2 mg ; Iodine ,1.5 mg and Cobalt , 0.25 mg.

** According to *NRC*, 1994.

Measurements and determinations:

At 50 days of age, the digestibility of nutrients was determined using 15 quail chicks from each treatment in a digestibility experiment. The birds were housed individually and fed the tested diets. After 3 days acclimatization period, the collection period continued for 6 days during which feed intake was measured and excreta output was collected daily, oven dried (70°C for 24 hrs), weighed and ground. Representative samples of diets and dried excreta were used for analysis of DM, EE, CP, CF, and ash according to AOAC (1999) methods. Nitrogen – free extract was calculated according to Abou-Raya and Galal (1971). Fecal nitrogen was determined following the procedure outlined by Jakobsen *et al.* (1960) in order to determine CP digestibility % . Fractionation of fibers in okara meal (Table 1) has been done by determining neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) according to Goering and Van Soest (1970). Hemi cellulose was calculated as the difference between NDF and ADF, while cellulose was calculated as the difference between ADF and ADL.

Feed intake, live body weight were recorded every week. Also, body gain and feed conversion (g feed: g gain) were calculated every week.

The economical efficiency of the product was calculated from the money output-money input analysis and represented as net revenue per unit of total costs under local conditions.

Data were subjected to ANOVA using the procedure outlined in SAS® software (SAS, 1994). Two way analysis of variance was used in the experiment using the following model:

$$Y_{ijk} = \mu + a_i + b_j + ab_{ij} + e_{ijk}$$

Where;

Y_{ijk} represents the ijkth observation of any trait measured, μ is the population mean, a_i is the fixed effect of the ith Okara levels (i = 1, 2,3,4), b is the fixed effect of the jth enzyme supplementation (j =1, 2), ab_{ij} is interaction effect between fixed factors and e_{ijk} is the error term.

Differences among means at the probability of $P \leq 0.05$ were considered significant, and were separated by Duncan's multiple range test (*Duncan*, 1955).

RESULTS AND DISCUSSION

The proximate chemical analysis of okara meal was presented in Table 1. The chemical analysis of okara showed that it contains reasonable proportion of CP being 36.5 %. Besides, the amino acids content of okara meal exceeds that of soybean meal. This means that such by-product ingredient can be utilized as an alternative dietary protein source for SBM in feeding quail.

Digestibility coefficients:

Digestibility of nutrients as affected by feeding different dietary treatments is summarized in Table (3). No significant differences ($P<0.05$) were detected in digestibility of dry matter (DM) due to feeding quail chicks okara meal with or without prozyme. Results showed significant improvement in crude protein (CP), NFE and ether extract (EE) digestibility values due to using okara meal at 20 % of soybean meal. This may be due to the heating treatment of okara which might improve the utilization of its nutrients content. These results are in agreement with those obtained by Abd-Elsamee *et al.* (2005) who found slightly improvement in CP and EE digestibility with using okara as replacing for soybean meal in broiler chick diets. While, there were improvements in the digestibility of crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen free extract (NFE) due to adding prozyme to both control diet and okara diets. The positive responses in nuttients digestibility with enzyme addition are in agreement with El-Sebai and Osman (1999); Kies and Selle (1999); El-Nagmy *et al.*(2001) and Ibrahem (2006) who reported that the improvement in nutrient digestibility resulting from adding enzyme may be due to the improving in nutrients absorption especially crude protein.

Table (3): Effect of treatments on nutrients digestibility (%).

Treatments			Nutrients digestibility (%)				
No.	Okara	Prozyme	DM	CP	EE	CF	NFE
Main effect of okara meal							
	0	-	81.95^{b} ±0.34	92.02^{b} ±0.41	71.18^{b} ±0.49	23.27^{a} ±1.23	83.02^{b} ±0.72
	20	-	82.68^{a} ±0.40	93.33^{a} ±0.41	77.85^{a} ±0.78	22.09^{b} ±1.13	84.59^{a} ±0.22
	40	-	80.32^{c} ±0.29	91.06^{c} ±0.42	71.20^{b} ±0.70	20.73^{c} ±1.20	81.24^{c} ±0.35
	60	-	79.27^{d} ±0.32	89.82^{d} ±0.64	70.89^{b} ±1.23	20.13^{c} ±1.88	80.53^{d} ±0.15
Main effect of prozyme							
		0	80.23^{b} ±0.32	90.30^{b} ±3.67	70.62^{b} ±0.69	17.53^{b} ±0.46	81.58^{b} ±0.35
		0.50	81.88^{a} ±0.35	92.91^{a} ±0.26	74.95^{a} ±0.78	25.58^{a} ±0.26	83.10^{a} ±0.50
Effect of interaction							
1	0	0.00	81.14 ±0.18	90.69^{e} ±0.24	69.76^{d} ±0.13	19.63^{d} ±0.14	80.88^{cd} ±0.12
2	0	0.50	82.64 ±0.40	93.19^{b} ±0.90	72.59^{c} ±0.27	26.90^{a} ±0.37	85.14^{a} ±0.16
3	20	0.00	81.64 ±0.39	92.15^{cd} ±0.19	75.55^{b} ±0.32	18.72^{e} ±0.19	84.09^{b} ±0.29
4	20	0.50	83.71 ±0.20	94.50^{a} ±0.21	80.14^{a} ±0.16	25.45^{b} ±0.17	85.08^{a} ±0.06
5	40	0.00	79.53 ±0.24	89.84^{f} ±0.07	69.45^{d} ±0.34	17.23^{f} ±0.50	80.83^{cd} ±0.19
6	40	0.50	81.10 ±0.05	92.29^{c} ±0.19	72.95^{c} ±0.73	24.24^{c} ±0.34	81.66^{c} ±0.65
7	60	0.00	78.60 ±0.45	87.97^{g} ±0.34	67.66^{e} ±0.20	14.52^{g} ±0.20	80.53^{d} ±0.24
8	60	0.50	79.94 ±0.21	91.76^{d} ±0.14	74.13^{bc} ±1.24	25.74^{b} ±0.38	80.53^{d} ±0.20

a, b, c.... Means in each column, within each item, bearing the same superscripts are not significantly different (P < 0.05).

Growth performance:

1- Live body weight and weight gain:

The effects of different okara meal levels and prozyme supplementation on live body weight and weight gain are shown in Table (4). It could be observed that the use of 20 % okara meal as replacing for soybean meal significantly (P<0.05) increased body weight and body weight gain. On the other hand, no significant differences in body weight and body weight gain values were observed due to increasing okara meal up to 40 or 60 % of soybean meal compared to control group.

The effect of prozyme supplementation on body weight and body weight gain is presented in Table 4. It could be noticed that body weight and body weight gain increased significantly by about 1.6 % and 1.64 %, respectively, compared to the control without enzyme supplementation.
The effect of interaction between prozyme and okara (Table 4), showed that prozyme supplementation to different levels of okara meal significantly ($P<0.05$) increased the average values of live body weight and weight gain.The positive effect of prozyme may be due to the improvement in the digestibility of nutrients as a result of adding prozyme to quail chick diets. This result had been confirmed previously by Ibrahem (2006) who obtained that supplemental microbial phytase to broiler chick diets containing 25 % okara as replacing for soybean meal increased weight gain compared to control group.

Table (4): Effect of treatments on Japanese quail chicks performance.

Treatments			Initial BW	Final BW	Weight	Feed	Feed
No.	Okara	Prozyme	(g)	(g)	gain (g)	intake (g)	conversion
Main effect of okara							
	0	-	10.70 ±0.08	197.33^{b} ±1.28	186.63^{b} ±1.29	691.00^{d} ±2.97	3.70^{c} ±0.03
	20	-	10.71 ±0.11	205.55^{a} ±1.93	194.79^{a} ±1.86	705.83^{c} ±5.98	3.63^{c} ±0.06
	40	-	10.57 ±0.16	198.53^{b} ±0.59	187.96^{b} ±0.62	719.00^{b} ±3.65	3.83^{b} ±0.03
	60	-	10.74 ±0.16	195.67^{b} ±0.92	184.93^{b} ±0.86	733.00^{a} ±4.04	3.96^{a} ±0.04
Main effect of prozyme							
		0	10.64 ±0.09	197.67^{b} ±1.30	187.04^{b} ±1.28	717.33^{a} ±5.03	3.84^{a} ±0.04
		0.50	10.74 ±0.09	200.85^{a} ±1.38	190.11^{a} ±1.38	707.08^{b} ±5.55	3.72^{b} ±0.05
Effect of interaction							
1	0	0.00	10.73 ±0.14	194.67^{d} ±0.88	183.93^{d} ±0.90	693.33^{c} ±4.41	3.77^{cd} ±0.01
2	0	0.50	10.67 ±0.10	200.00^{bc} ±0.58	189.33^{bc} ±0.53	688.67^{c} ±4.37	3.64^{de} ±0.10
3	20	0.00	10.66 ±0.23	204.00^{ab} ±2.00	193.34^{ab} ±1.77	728.67^{b} ±1.33	3.72^{cd} ±0.40
4	20	0.50	10.76 ±0.12	207.00^{a} ±3.51	196.24^{a} ±3.47	693.00^{c} ±3.51	3.54^{e} ±0.08
5	40	0.00	10.59 ±0.20	197.67^{cd} ±0.88	178.08^{cd} ±1.07	722.33^{ab} ±6.74	3.86^{abc} ±0.05
6	40	0.50	10.56 ±0.29	199.4^{bcd} ±0.43	188.6^{bcd} ±0.14	715.67^{b} ±3.18	3.79^{bc} ±0.02
7	60	0.00	10.52 ±0.24	194.33^{d} ±1.21	183.81^{d} ±1.07	735.00^{a} ±5.77	4.00^{a} ±0.05
8	60	0.50	10.96 ±0.16	197.00^{cd} ±1.00	186.04^{cd} ±1.15	731.00^{ab} ±6.66	3.93^{ab} ±0.06

a, b, c.... Means in each column, within each item, bearing the same superscripts are not significantly different ($P < 0.05$).

2- Feed intake and feed conversion ratio:

The effects of experimental treatments on feed intake and feed conversion ratio are presented also in Table (4). Results obtained indicated that feeding quail chicks on diets containing high levels of okara meal (40 or 60 %) as replacing for soybean meal without supplemental enzyme increased feed intake values and recorded the worst feed conversion values compared to control group. While, there were no significant ($P<0.05$) differences in average values of feed conversion due to using okara meal at dietary level of 20 % instead of soybean meal. On the other hand, adding prozyme to quail chick diets significantly ($P<0.05$) decreased feed intake and improved feed conversion value comparing to those fed diets without prozyme supplementation. These results are in agreement with those obtained by Abd-Elsamee *et al.* (2005) who found no-significant differences in feed conversion values when broiler chicks were fed diets containing 20 % okara meal as replacing for soybean meal compared to control group. Also, Ibrahem (2006) obtained an improvement in feed conversion values due to adding microbial phytase to broiler chick diets containing 25 % okara as replacing for soybean meal.

3- Economical efficiency:

The final body weight and feed cost are considered the most important factors involved in the achievement of maximum efficiency of meat production. The effect of dietary treatments on economical efficiency is presented in Table (5). Results indicated that replacing okara meal for soybean meal at levels of 20, 40 or 60 % either without or with enzyme supplementation in Japanese quail chick diets decreased the average values of total cost/kg live body weight and increased economical efficiency values compared to control group.

This may be attributed to lower price/ton of the diet with using graded levels of okara meal as replacing for soybean meal (Table 2). In this connection, Abd-Elsamee *et al.* (2005) found that replacing okara for soybean meal at levels of 20, 40, 60 or 80% in broiler chick diets increased economical efficiency values compared to control group (without okara meal). Similarly, Ibrahem (2006) obtained that the economical efficiency values were improved when broiler chicks were fed diets containing 25 % okara as replacing for soybean meal either supplemented or un-supplemented with microbial phytase. On the contrary, El-Manylawi (2007) showed no improvement in average values of economical efficiency due to using okara meal at levels of 25, 50 or 75 % as replacing for soybean meal in growing rabbit diets.

On the basis of the results of this study, it could be concluded that Japanese quail chicks could be fed diets containing different levels of okara meal up to 60 % as replacing for soybean meal either without or with enzyme supplementation without adversely effect on both quail chick performance, nutrients digestibility and economic efficiency.

Table (5): Effect of treatments on economic efficiency.

Treatments			Fixed cost [a] (LE)	Feed cost (LE)	Total cost (LE)	Live B.W (kg)	TotalCost/kg BW (LE)	Total reve. [b] (LE)	Net reve. (LE)	EEf [c]	Relat. EEf [d]
No.	Okara	Prozy.									
Main effect of okara											
	0	-	0.50	1.35	1.85	0.197	9.36	3.90	2.10	1.13	100
	20	-	0.50	1.33	1.83	0.205	8.91	4.11	2.28	1.24	110
	40	-	0.50	1.28	1.78	0.198	8.99	3.97	2.18	1.22	108
	60	-	0.50	1.23	1.73	0.195	8.87	3.91	2.17	1.25	111
Main effect of prozyme											
		0	0.50	1.29	1.79	0.198	9.09	3.95	2.16	1.20	100
		0.50	0.50	1.30	1.80	0.201	8.98	4.01	2.21	1.22	102
Effect of interaction											
1	0	0.00	0.50	1.34	1.84	0.195	9.43	3.90	2.06	1.12	100
2	0	0.50	0.50	1.36	1.86	0.200	9.30	4.00	2.14	1.15	103
3	20	0.00	0.50	1.34	1.84	0.204	9.02	4.08	2.24	1.22	109
4	20	0.50	0.50	1.32	1.82	0.207	8.79	4.14	2.32	1.27	113
5	40	0.00	0.50	1.28	1.78	0.198	8.99	3.96	2.18	1.22	109
6	40	0.50	0.50	1.29	1.79	0.199	8.99	3.98	2.19	1.22	109
7	60	0.00	0.50	1.23	1.73	0.194	8.92	3.88	2.15	1.24	111
8	60	0.50	0.50	1.24	1.74	0.197	8.83	3.94	2.20	1.26	112

a) Bird price and rearing cost.
b) Assuming that the selling price of one kg live body weight is 20 L.E.
c) Net revenue per unit total cost.
d) Considering the diets both containing 0 okara , 0 prozyme and number 1 as a controls.

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الحد من التلوث البيئي وإنتاج لحوم سمان رخيصة عن طريق استبدال كسب فول الصويا بمسحوق الأوكارا مع إضافة إنزيم

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استخدم فى هذه الدراسة عدد ٦٠٠ كتكوت سمان ياباني عمر يوم وذلك لدراسة تأثير إحلال مسحوق الاوكارا محل كسب الصويا بمستويات مختلفة مع إضافة البروزيم على الأداء الإنتاجى ، معاملات الهضم ، الكفاءة الاقتصادية فضلا عن الحد من التلوث البيئي . تم تقسيم الطيور عشوائيا إلى ٨ معاملات متساوية
(ثلاث مكررات بكل معاملة، ٢٥ طائر / مكرر). تم إستخدام ٤ مستويات من مسحوق الأوكارا (صفر ، ٢٠ ، ٤٠ ، ٦٠ % إستبدال من كسب فول الصويا) كل مع مستويين من البروزيم (صفر ، ٠,٥ كجم / طن من العليقة) فى تصميم عشوائى متداخل ٤ × ٢ . تم مقارنة المعاملات المحتوية على مسحوق الاوكارا بعليقه المقارنة التي تم تركيبها بحيث لا تحتوى على أى من مسحوق الاوكارا أو البروز يم . تم تربية الطيور فى بطاريات تحت نفس الظروف من الرعاية طوال فترة التجربة التى استمرت لمدة ٧ اسابيع .
أوضحت نتائج هذه التجربة أن تغذية كتاكيت السمان اليابانى على علائق تحتوى على ٢٠ % من مسحوق الأوكارا بدلا من كسب فول الصويا أدى إلى تحسن معامل هضم كل من البروتين الخام ومستخلص الإثير بينما أدى إضافة البروز يم إلى علائق كتاكيت السمان اليابانى المحتوية على مسحوق الأوكارا إلى تحسن معامل هضم المركبات الغذائية المختلفة مقارنة بمجموعة المقارنة . أدى استخدام مسحوق الأوكارا بمستوى ٢٠ % بدلا من كسب الصويا إلى تحسن معنوى فى قيم كل من الوزن الحى والزيادة فى الوزن . كما أدى إضافة البروز يم إلى العلائق المحتوية على مستويات مختلفة من مسحوق الاوكارا إلى زيادة الوزن الحى ، الزيادة فى الوزن ، إنخفاض كمية الغذاء المأكول ، تحسن كفاءة التحويل الغذائى بينما أدى تغذية كتاكيت السمان اليابانى على علائق تحتوى على مستويات مختلفة من مسحوق الأوكارا كبديل لكسب الصويا بدون إضافة إنزيم إلى زيادة الغذاء المأكول وتسجيل أسوء القيم لكفاءة التحويل الغذائى . أوضحت النتائج أن إحلال مسحوق الأوكارا محل كسب الصويا بنسب ٢٠ ، ٤٠ أو ٦٠ % بدون أو مع إضافة انزيم أدى إلى إنخفاض تكلفة إنتاج كجم وزن حى وزيادة قيم الكفاءة الإقتصادية مقارنة بمجموعة المقارنة .
من خلال نتائج هذه الدراسة يمكن التوصية بإمكانية تغذية كتاكيت السمان اليابانى على علائق تحتوى على مستويات مختلفة من مسحوق الأوكارا حتى ٦٠ % كإستبدال من كسب الصويا بدون أو مع إضافة انزيم دون حدوث تأثير ضار على كل من الأداء الإنتاجى ، معاملات الهضم ، الكفاءة الإقتصادية .