EFFECTS OF DIFFERENTLY PROCESSED RUBBER SEED MEAL BASESD DIETS ON PERFORMANCE AND EGG QUALITIES OF LAYING HENS

S.K. Akinsanmi; C.O. Joachim; O.B. Omotosho; F.A. Igbasan and J.O. Agbede
Department of Animal Production and Health, Federal University of Technology, Akure www.futa.edu.ng
Correspondence: akinsanmikayode@gmail.com

Abstract

This study was conducted to evaluate the effects of incorporation of differently processed rubber seed meal (RSM) in layers mash on the performance of laying hens and egg qualities. The seed used were manually dehulled and differently processed, using roasting (RRSM) and soaking in hot water (HWRSM) methods. The RSMs were incorporated into laying hens diets as replacement of soybean meal at 0, 15, 25 and 35%. The results revealed no significant variations in all performance variables measured. The regression analysis indicates that only 6.2, 6.6 and 7.9% of the variations in final weight, weight gain and rate of laying respectively were due to the dietary treatments. Dietary treatment also responsible for 3.7 and 13.2% of the variations observed in feed intake and feed conversion ratio of the birds. The performance of laying hens recorded in term of egg weight, hen day egg production, yolk index, Haugh units and shell thickness were higher than what was reported by previous researchers for birds fed soybean based diets from different countries. Egg weight, egg mass output, albumen weight of the test diets were higher than that of control diets, they increase as the levels of incorporation of RSM increases. This affirm the fact that RSM can perform as much as soybean meal in the feed of laying birds. The performance of RSM based treatments could be linked to nutrient quality of RSM. Rubber seed was reported to be higher than soybean in essential amino acid with higher rate of digestibility

Keywords: *rubber seed meal (RSM), soybean meal, Hen day egg production, Haugh unit, egg mass output.*

Introduction

The incorporation of non- conventional feedstuffs (NCFs)into livestock feeding is a major step in reducing the high cost of production of animal products especially now that the country is facing economic meltdown. Rubber seed is one of such NCFs that are been produced in large quantity in Nigeria but only few of them are used for seedlings and the remaining lie waste in the farm. Research has shown that the nutrient composition of RSM ranged from; metabolizable energy (1828.65- 2675.61kcal/kg), crude protein (22.16-40.36%,), ether extract (12.41 to 55.67%), crude fibre (2.65 - 3.62 %,), ash (2.20%-6.57%) and carbohydrate (14.09 - 41.48) (Oyewusi *et al*., 2007, Eka *et al*., 2010 and Akinsanmi *et al*., 2017)The range of metabolic energy of RSM (1828.65- 2675.61kcal/kg) fall within the range of ME in other pulses used feeding livestock. Olomu (2011) reported the values of 2750, 2460 and 2069 ME (Kcal/kg) for groundnut cake, soybean cake and cotton seed cake. The high energy values of RSMs show that the meal could also be used as energy source to replace maize in livestock feed if it is properly processed (Stosic and Kaykay, 1991; Oyewusi, *et al*., 2007). It could be also used as plant protein source. Though RSM is reported to be high in cyanide (18/100g6mg) (Eka *et al*., 2010), Offiong and Olomu (1990) also confirmed that those anti nutritional factors found in rubber seed are heat labile and are reduced to an insignificant nontoxic level while toasted (105^0 C) or stored for 4-6 months before used. Some research works have been carried out on feeding trials of RSM based diets in broilers and pigs with positive responses, but laying hens and egg qualities are left out of adequate investigations and this from the basis for this study.

Materials and Methods

The experiment was carried out in Abivict Poultry Farm of Ilara Mokin, Ifedore Local Government of Ondo State, Nigeria. Rubber seeds were obtained from Ilushin rubber estate, Ogun state, Nigeria. They were manually dehulled and differently processed, using roasting (RRSM) and soaking in hot water (HWRSM)

methods. A basal diet was formulated to meet the nutrient requirements (NRC, 1994) of laying hens. RSM samples from the two treatments were incorporated into the basal diets at equi-protein replacement proportion with soybean meal at 0, 15, .25, and 35% as shown in Table 1. A total of 189 Harco black laying chickens at 29 weeks of age were housed in a Three (3) tier California type colony cages (43×41cm), Three (3) birds per cage unit, Three (3) cage units per replicate, and 3 replicates per treatment making a total of Twenty seven (27) birds per treatment in an open-sided, naturally ventilated experimental hen house. The cages were equipped with open galvanized feeders and automated water troughs. Feed and water were provided *ad libitum* throughout the experimental period. The experimental design was Complete Randomized with 2 by4 factorial design. The duration of the experiment was 112 days (16 weeks) which was subdivided into 4 periods of Twenty eight (28) days each. The hens were individually weighed at the beginning and at the end of the experiment to determine the change in weight. Egg production was recorded daily for each replicate and average egg production rates (hen-day percentage) were pooled to obtain the percent hen-day production for every period. The hen-day percentage was calculated as

$$\frac{\text{Total number of eggs laid}}{\text{Number of birds alive.}} \times 100$$

Feed consumption for each replicate was determined at the end of each period and was used to calculate average daily feed intake (FI) per bird. Feed utilization was calculated using egg production and feed consumption data as:

$$\frac{\text{Feed consumed (kg)}}{\text{Dozens of eggs laid}}$$

Egg mass outputs were calculated as; rate of lay (%) / average egg weight. The performance within every Twenty eight (28) days were pooled together and recorded.

On the last Three (3) consecutive days of each period, all eggs laid were gathered from each replicate and were identified and used for internal and external egg qualities determination as described by Igbasan and Guenter (1999).

The eggs collected were weighed in the laboratory on a sensitive weighing balance to determine average egg weights. Specific gravity on these eggs was determined using the floatation method described by Hamilton (1982). The eggs were carefully broken on a white tile (30×30cm square) with a blunt edge knife to determine the shell weight, shell thickness, albumin weight, albumin length, albumin width, albumin height, yolk weight, yolk length, yolk height, yolk colour and yolk index. Others include egg length and egg width. The shells were air-dried without the shell membrane for 5 days before weighing using a sensitive and micrometer screw gauge to determine the shell weight and thickness respectively according to Igbasan and Guenter (1999). Egg length and width were determined using vernier calipers. Also the yolk height, yolk width and length, albumin length and width were measured using a divider, the yolk colour was determined using the Roche Yolk Colour Fan, while the yolk index, and haugh unit were calculated as follows: Yolk index = yolk height/yolk length. Haugh unit = $100\log (H + 7.5 - 1.7W^{0.37})$ (Oluyemi and Roberts, 2000).Where H= height of albumin, W = egg weight. Farm budgeting analysis technique and financial ratios were used to analyze the cost and return data on laying hens performance. A gross margin analysis was conducted on each of the diets to determine the profitability of each of the diets used. Gross margin (GM) = GR – TVC GR = gross revenue, TVC = total variable cost. Gross revenue = Q X P Q = output of the laying hen (eggs produce and laying hen) P = price per create of eggs and the price of the laying hen after the experiment Total variable cost is the addition of the cost of all variable inputs used during the study. This analytical tool was used to test the profitability or otherwise of laying hen enterprise based on RSM based diets. The profitability of using RSM as alternative feed resources for poultry feed formulation was compared with conventional feedstuffs. The profitability of graded levels were compared among the treatments. The results were used to assess the profitability of the test treatments and to determine the return per naira invested into laying hen enterprises

Table 1: Gross composition (%) of commercial laying hens diets with graded levels of differently processed rubber seed meals

Ingredient	**Control**		**RRSM**			**HWRSM**	
Inclusion level	**0%**	**15%**	**25%**	**35%**	**15%**	**25%**	**35%**
Maize	53.50	51.45	50.35	49.00	50.53	48.80	48.11
Wheat offals	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Soybean meal	22.00	18.70	16.50	14.30	18.87	16.50	14.30
RRSM (28.02%CP)	0.00	4.95	8.25	11.65	0.00	0.00	0.00
HWRSM (23.63%CP)	0.00	0.00	0.00	0.00	5.87	9.80	13.69
Groundnut cake	2.00	2.45	2.45	2.45	2.45	2.45	2.45
Fishmeal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bone meal	6.50	6.50	6.50	6.50	6.50	6.50	6.50
Oyster shell	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vegetable oil	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated values							
ME(kcal/kg)	2880.93	2850.30	2832.30	2826.72	2848.70	2829.18	2831.36
Crude Protein	17.32	17.56	17.47	17.10	17.48	17.33	17.11
Crude Fibre	2.97	2.89	2.83	2.77	2.90	2.85	2.73
Calcium	4.44	4.56	4.43	4.43	4.43	4.43	4.42
Av. Phosphorus	1.08	1.06	1.04	1.04	1.06	1.05	1.02
Lysine	1.18	1.34	1.45	1.56	1.39	1.53	1.66
Methionine	0.50	0.58	0.65	0.71	0.61	0.68	0.76
Analysed values							
MC	8.70	8.44	8.50	8.00	8.41	8.53	8. 42
Total Ash	6.32	6.42	6.45	6.51	6.31	641	6.45
Crude Protein	16.97	16.99	16.93	16.91	16.97	16.96	16.94
Crude Fibre	3.10	3.09	3.10	3.02	3.02	3.00	3.00
Fat	5.12	5.20	5.23	5.50	5.20	5.39	5.53

Results and Discussion

The dietary effects of feeding commercial laying hens with graded levels of replacement of soybean meal with differently processed RSM on production performance was expressed in Table 2 collaborated with regression equations in Table 5, revealed non-significant variations in all the parameters measured due to dietary treatments. Final body weight and body weight gained were with the prediction regression equation ($y = 19.02x + 0.62x^2 + 1967.47$, $R^2 = 0.062$ and pv= 0.564 and $y = 0.753x + 0.17x^2 + 158.90$, $R^2 = 0.066$, PV = 0.543) respectively. The equation revealed that dietary treatment only responsible for 6.2% and 6.6%of variations observed in the final body weight and weight gained by commercial laying hens used for this study. The levels of significance as measured by p values showed that the parameters were not significant (P>0.05) at 56.4 and 54.3%. The rate of laying ($y = -0.085x + 0.002x^2 + 87.437$, R^2 0.079, pv = 0.575) also indicates non-significant variation of 7.9% due to dietary treatment in the laying capacity of the birds compared with control diet. So also total feed intake ($y = -136.314x + 3.257x^2 + 12661.84$, R^2 =0.037 and pv = 0.711) and feed conversion ratio ($y = 0.002x - 8.977 \times 10^{-7}x^2 + 1.499$, $R^2 = 0.132$ pv = 0.279) showed that dietary treatment accountable for 3.7 and 13.2% of the variation observed from the birds. Affirming the fact that RSM can perform as much as soybean in the feed of the laying birds. The performance of RSM based treatments could be linked with nutrient quality of RSM.Rubber seed was reported to be higher than soybean in essential amino

acid and have higher rate of digestibility (Ekal, *et al.*, 2010). It is higher in lysine, phenylalanine and valine than maize and higher in isoleucine, leucine, threonine and valine than reference protein pattern recommended by NAS/NRC (1980). Egg laying percentage which is the major index of performance in commercial laying hens, accounts for about 90% of the income in egg production farms (Oluyemi and Robert, 2000) were not showing significant variations, confirming that RSM is a good potential feedstuff for laying birds as suggested by Pech, (2002). The range of egg weight on test diet (61.87-62.98g) fall within the standard ranged (53-63g) but higher than mean of hen day production (48.05-53.33g) reported for most exotic and hybrid layers in Nigeria .Oluyemi and Rorbert (2000) established the fact that hen day production and egg qualities has positive relationship with the quality of feed. Egg weight is a determinant of economics values of egg production, it determined the price received in any market and the standard ranged between 53-63g (Obioha, 1992). Feed intake and feed conversion ratio of the birds fed control diet were a little less than that of the birds fed test diets. This may due to presence of residual of anti-nutritional factors in the test diets that affected the intake of the feed. Agbede and Aletor (2003) reported that differences in feed intake and feed conversion ratio could be due to differences in the nutritive values of the diets.

Table 2: Production performance of laying hens fed graded levels of equi-protein replacement of soybean meal with rubber seed meals based diets

Diet	% inclusion of RSM	Initial weight (g)	Final weight (g)	Body weight gain (g)	Daily feed intake (g)	Total feed intake (g)	Rate of laying (%)	FCR	Egg weight (g)	Egg mass output
Level	0	1858.33	2016.67	158.33	109.39	12293.33	87.47	1.50	63.61	55.64
	15	1860.33	2012.42	152.67	109.18	12246.255	86.49	1.51	62.41	53.99
	25	1860.29	2009.17	149.17	111.51	12272.41	86.47	1.55	62.36	53.92
	35	1860.83	2014.67	153.83	111.54	12436.25	86.56	1.55	62.28	53.90
SEM		3.23	2.82	4.39	0.58	0.72	1.54	0.62	0.69	0.65
Pv		0.98	0.35	0.79	0.24	0.32	0.99	0.38	0.99	0.99
Treatment	RRSM	1860.34	2018.56	150.56	109.36	12284.61	86.46	1.52	62.63	54.05
	HWRSM	1860.78	2014.00	153.22	112.13	11151.83	86.55	1.55	62.07	53.71
SEM		2.88	4.36	4.36	0.62	33.84	1.52	0.52	0.62	0.67
Pv		0.83	0.29	0.65	0.04	0.33	0.89	0.19	0.48	0.58
Trt x level										
Control	0	1868.33	2016.67	158.34	109.39	12293.33	87.47	1.50	63.61	55.64
RRSM	15	1860.23	2041.05	150.87	107.38	12061.33	86.61	1.49	62.95	54.53
RRSM	25	1860.41	2010.89	150.89	109.55	12270.25	85.97	1.52	62.43	53.92
RRSM	35	1860.67	2011.67	151.67	111.14	12522.51	85.91	1.55	62.52	54.02
HWRSM	15	1860.67	2016.56	155.33	113.46	12483.67	86.37	1.54	61.87	53.45
HWRSM	25	1860.20	2008.33	148.33	111.93	12383.56	86.27	1.58	62.30	53.91
HWRSM	35	1861.67	2014.67	156.06	112.54	12350.67	86.00	1.55	62.03	53.77
SEM		3.99	3.27	6.40	1.12	60.26	0.70	0.92	0.89	0.90
Pv		0.99	0.34	0.87	0.54	0.33	0.94	0.62	0.88	0.85
Significance										
Level		NS	NS	NS	NS	NS	NS	NS	NS	NS
Treatment		NS	NS	NS	NS	NS	NS	NS	NS	NS
Level x trt		NS	NS	NS	NS	NS	NS	NS	NS	NS

Keys: Trt: treatment; RRSM: roasted rubber seed meal; HWRSM: Hot water rubber seed meal; FCR: Feed conversion ratio; NS not significant. Means of the same superscript are not significantly different ($p>0.05$).

Egg qualities parameters measured as expressed in Table 2 and 3, revealed that egg length, yolk colour, albumen weight, albumen width, shell thickness, shell weight and egg specific gravity were significant affected by dietary treatments. Egg weight, egg mass output, albumen weight of the test diets were higher than that of control diet, they increase as the levels of incorporation of RSM increases. The performance of laying hens recorded in term of egg weight, hen day egg production, yolk index, Haugh units and shell thickness were higher than the one reported by Park *et al* (2003) from birds fed soybean based diets from different countries, but contradicts to the reports of Ravindran (1995),who conducted experiments on rubber seed meal, cassava leaf meal, Ipil leaf meal as substitute for soybean meal in commercial laying hens feed with reports of significantly lower performances in body weight, feed intake, and egg production

Table 3: Egg external quality characteristics of commercial laying hens fed with graded levels of differently processed rubber seed meals based diets

Diets	**% inclusion of RSM**	**Egg weight (g)**	**Egg length (cm)**	**Egg width (cm)**	**Egg mass output**	**Huagh unit**	**Shell weight (g)**	**Shell thickness (mm)**	**Egg specific gravity**
Level	0	63.61	4.87	4.13	55.64	84.95	6.90	0.33	1.07^{c}
	15	62.83	5.53^{a}	4.12	53.99	80.54	7.28	0.40	1.07^{c}
	25	62.36	5.55^{a}	4.15	53.91	86.18	7.75^{a}	0.43^{b}	1.08^{b}
	35	62.28	5.37^{b}	4.22	53.90	87.35	8.00^{a}	0.45^{a}	1.09^{a}
SEM		0.60	0.27	0.06	0.67	0.36	0.15	0.01	0.03
Pv		0.99	0.69	0.24	0.99	0.37	0.01	0.01	0.01
Treatment	RRSM	62.63^{a}	5.56^{a}	4.21	54.15	81.28	7.81^{a}	0.42^{b}	1.04
	HWRSM	62.07^{b}	5.39^{b}	4.11	53.71	82.09	7.54^{b}	0.43^{a}	1.03
SEM		0.62	0.05	0.03	0.55	0.33	0.13	0.01	0.03
Pv		0.48	0.36	0.05	0.59	0.27	0.05	0.04	0.09
Level x treat									
Control	0	63.61	4.87^{b}	4.13	55.64	84.95	6.90	0.34^{c}	1.07^{c}
RRSM	15	62.95	5.65^{a}	4.13	54.53	79.83	7.35	0.40^{b}	1.07^{c}
RRSM	25	62.43	5.65^{a}	4.20	53.92	81.36	7.88	0.42^{b}	1.08^{b}
RRSM	35	62.52	5.40^{a}	4.30	54.01	82.66	8.20	0.44^{a}	1.09^{a}
HWRSM	15	61.87	5.37^{ab}	4.10	53.45	81.25	7.22	0.41^{b}	1.07^{c}
HWRSM	25	62.30	5.47^{a}	4.10	53.91	91.01	7.62	0.44^{a}	1.08^{b}
HWRSM	35	62.03	5.33^{ab}	4.13	53.77	92.04	7;80	0.45^{a}	1.09^{a}
SEM		0.92	0.09	0.53	0.97	3.06	0.09	0..01	0.02
Pv		0.88	0.90	0.24	0.99	0.36	0.69	0.04	0.03
Significance	Level	NS	NS	NS	NS	NS	**	**	**
	Treatment	NS	*	NS	NS	NS	*	*	NS
	Level x treat	NS	NS	NS	NS	NS	NS	*	*

Keys: Treat: treatment, RRSM roasted rubber seed meal, HWRSM: hot water rubber seed meal, NS: not significant, * significant ($p< 0.05$); ** significant ($p<0.01$) means of the same superscript are not significantly different ($p >0.05$)

Table 4. Internal egg qualities of commercial laying hens fed diets with graded levels of differently processed rubber seed meals-based diets

Treatments	% inclusion of RSM	Yolk weight (g)	Yolk width (cm)	Yolk height (cm)	Yolk length(cm)	Yolk colour	Yolk index	Alb weight (g)	Alb width (cm)	Abllen gth (cm)	Albhei ght (cm)
Level	0	15.63^{b}	3.50	2.38^{b}	4.14	6.00^{b}	0.68	41.77^{b}	6.82	8.53	1.67
	15	15.73^{ab}	3.48	2.41^{ab}	4.03	6.00	0.70	42.00^{ab}	6,81	8.59	1.68
	25	15.77^{a}	3.48	2.43^{ab}	4.15	6.00	0.70	42.00^{ab}	6.87	8.39	1.68
	35	15.92^{ab}	3.51	2.44^{a}	4.13	7.00^{a}	0.70	42.98^{a}	6.87	8.43	1.68
SEM		0.12	0.04	0.12	0.05	0.20	0.01	0.31	0.02	0.04	0.01
Pv		0.007	0.708	0.028	0.780	0.001	0.702	0.010	0.405	0.059	0.170
Treatment	RRSM	15.64^{a}	3.53	2.45^{a}	4.19	0.67^{a}	0.70	43.15^{a}	6.95^{a}	8.51	0.85^{b}
	HWRSM	15.53^{b}	3.45	2.40^{b}	4.11	6.11	0.70	41.64^{b}	6.74^{b}	8.43	0.92
SEM		0.09	0.02	0.09	0.03	0.18	0.01	0.29	0.02	0.04	0.01
Pv		0.001	0.520	0.010	0.060	0.008	0.910	0.009	0.001	0.230	0.010
Trt x level											
Control	0	15.63	4.13	2.38	3.50	6.00	0.68	41.77^{b}	6.82^{b}	8.53	1.67
RRSM	15	15.73	4.10	2.42	3.51	6.33^{b}	0.69	42.57^{ab}	6.90^{a}	8.63	1.67
RRSM	25	15.67	4.26	2.44	3.51	6.67^{ab}	0,69	42.98^{ab}	6.89^{b}	8.45	168
RRSM	35	15.63	3.57	2.47	4.19	7.00	0.71	43.90^{a}	6.97^{a}	8.45	1.69
HWRSM	15	15.53	3.44	2.39	3.96	5.33	0.70	41.83^{b}	6.75^{c}	8.54	1.67
HWRSM	25	15.67	3.44	2.41	4.03	6.00	0.70	41.01^{c}	6.75^{c}	8.34	1.68
HWRSM	35	15.40	3.46	2.41	3.95	7.00	0.70	42.07^{ab}	6.77^{c}	8.41	1.69
SEEM		0.12	0.04	0.08	0.06	0.01	0.01	0.57	0.03	0.05	0.02
Pv		0.16	0.69	0.72	0.93	0.10	0.69	0.34	0.89	0.89	0.64
Significance	Level	NS	NS	NS	NS	**	NS	NS	NS	*	NS
	Treatmen t	**	NS	**	NS	*	NS	*	*	NS	*
	Trt x level	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Keys: Trt: treatment, RRSM roasted rubber seed meal, HWRSM: hot water rubber seed meal, Alb: Albumen NS: not significant, * significant($p< 0.05$); ** significant ($p<0.01$) SEM: standard error of measurement; means of the same superscript are not significantly different ($p >0.05$).

Table 5: Regression equations derived from parameters of performance and egg qualities commercial laying hens fed graded levels of differently processed RSM based diets

Parameters	Regression	R^2	Pv
Performance characteristics			
Replacement levels of RSM vs FBW	$Y_1 = -19.026x + 0.62x^2 + 1967.47$	0.062	0.564
Replacement levels of RSM vs BWG	$Y_2 = -0.753x + 0.17x^2 + 158.904$	0.066	0.543
Replacement levels of RSM vs ROL	$Y_3 = -0.085x + 0.002x^2 + 87.437$	0.079	0.475
Replacement levels of RSM vs TFC	$Y_4 = -136.31x + 3.257x^2 + 12661.84$	0.037	0.711
Replacement levels of RSM vsFCR	$Y_5 = 0.002x + -8.977 \times 10^{7}x^2 + 1.499$	0.132	0.279
Egg qualities			
Replacement levels of RSM vs Egg weight	$Y_6 = -0.0096x + 0.002x^2 + 63.563$	0.088	0.437
Replacement levels of RSM vs Egg mass output	$Y_7 = -0.137x + 0.003x^2$ 55.585	0.148	0.237
Replacement levels of RSM vs Albumen weight	$Y_8 = - 0.014x + 0.001x^2 + 741.884$	0.204	0.128
Replacement levels of RSM vs Yolk weight	$Y_9 = 0.008x + 0.00x^2 + 15.614$	0.268	0.061
Replacement levels of RSM vs Shell weight	$Y_{10} = 0.03x + 7.274 \times 10^{5}x^2 + 6.873$	0.879	0.000
Replacement levels of RSM vs Shell thickness	$Y_{11} = 0.024x + 0.001x^2 + 0.625$	0.964	0.000

Keys: FBW: final body weight, BWG: body weight gain, ROL: rate of laying, TFC: total feed consumed, FCR: feed conversion ratio, Pv: P values

The economics of commercial laying hen production used for this experiment as recorded in Table 6 revealed that the cost of production reduces as the level of replacement of soybean meal with processed rubber seed meal increases. The feed cost per bird/28 days was #342.97 for control diet, # 312.69 -#327.630 for RRSM based diet and #329.42 - #294.60 for HWRSM based diet. Total variable cost per bird also decreases as the levels of replacement increases across the treatments. Total variable cost per bird in control diet was #1833.47, the cost decreased from #1803.19 to #1766.80 in RRSM based diet and from #1819.32 to #1785.10 HWRSM based diet. This finding agreed with Fuller (2004) and Ijaiya *et al* (2011) who reported cost reduction in poultry production due to incorporation of rubber seed meal. Dafwang (2006) even corroborates the fact that low cost as the major attribute which the non- conventional feedstuff have over the conventional feed ingredients. Profitability indices such as net profit, profit/naira invested, gross margin and gross margin/naira invested, increase as the level of incorporation of RSM increases across the treatments. Going by the results of above mentioned profitability indices; Net profit of #237.08 for control treatment, #262.16 - #294.21 for RRSM based treatment and #244.51 - #276.56 for HWRSM based treatment and net profit/naira invested of 0.13 for control treatment, 0.14 – 0.17 for RRSM and 0.13-0.15 for HWRSM based treatment.

Table 6: Cost and return analysis of commercial laying hen performance (/bird/28 days) fed graded levels of differently processed RSM based diets.

Inclusion levels (%)	**Control**	**RRSM**			**HWRSM**		
	0	15	25	35	15	25	35
(a). Variable cost (#)							
Cost of stock	1350.00	1350.00	1350.00	1350.00	1350.00	1350.00	1350.00
Veterinary cost	10.50	10.50	10.50	10.50	10.50	10.50	10.50
Labour cost	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Utilities	30.00	30.00	30.00	30.00	30.00	30.00	30.00
(b). Fixed cost							
Depreciation cost	10.15	10.15	10.o15	10.15	10.15	10.15	10.15
Total fixed cost	10.15	10.15	10.15	10.15	10.15	10.15	10.15
Total production cost	1843.62	1813.34	1794.64	1776.64	1829.49	1811.98	1795.25
(c). Eggs laid	24.49	24.25	24.07	24.05	24.18	24.16	24.08
(d) Sales of eggs(#)	530.70	525.50	521.60	521.16	523.98	523.55	523.81
(e) Sales of layers	1550.00	1550.00	1550.00	1550.00	1550.00	1550.00	1550.00
Gross income	2080.70	2075.50	2071.60	2071.16	2073.98	2073.55	2071.81
Net profit	237.08	262.16	276.96	294.21	244.51	261.57	276.56
Net profit per naira invested	0.13	0.14	0.15	0.17	0.13	0.14	0.15
Gross margin	247.23	247.31	287.11	304.36	254.66	271.72	286.71
Gross margin per naira invested	0.13	0.15	0.16	0.17	0.14	0.15	0.16

Conclusion

In conclusion, feeding of commercial laying hens with processed RSM based diet is more economical than soybean meal based diet. Birds on RRSM based treatments performed better than HWRSM based treatment. Thirty-five percent (35%) level of incorporation of rubber seed meal mostly in RRSM based diet, recorded the highest net profit, net profit/naira invested and gross margin, indicating that incorporation of processed RSM up 35% replacement level into layers feed using the above method of processing will reduce cost of production and enhance profitability in poultry business.

References

Agbede, J.O. and Aletor, V.A. (2003). Evaluation of fish meal replaced with leaf protein concentrate from Glyricidia in diets for broiler chicks: Effect on performance, Muscle growth, haematology. and serum metabolites. *Int. J. Poul. Sci. 2(4): 242-250.*

Akinsanmi, S.K., Joachim, C.O., Sudik, S.D. Igbasan, F. A. And Agbede, J.O. (2017).Effect of

processing on the nutrients qualities of rubber (*Havea brasilensis*) seed meal. Proc. 42nd Ann. Conf. Nig. Soc. Anim. Prod. 26-30th March, 2017. Landmark University, Omu-Aran.

Dafwang I.I. (2006). Meat, eggs and milk from farm wastes: Explorations in animal Nutrition Research and Extension. An inaugural lecture delivered at NEARLS, ABU Zaria.

Eka, M.D, Tajul, A.A. and Wan Nadiah, W. A. (2010). Potential use of Malaysian rubber seed as food, feed and bio-fuel. *International Food Research Journal 17: 527-534*.

Fuller, M.F. (2004). The Encyclopaedia of farm animal nutrition. Pp488. Google book

Hamilton , R. M. G. (1982). Methods and factors that affect the measurement of shell quality. Poult. Sci. 61:2022–2039.

Igbasan, F.A. and Guenter, W.(1999). Effects of dietary manipulations of protein and energy in older layers on performance, egg size and egg shell quality. *Appl. Trop. Agric. Vol, 4, No. 2. Pp 82-86.*

Ijaiya, A.T., Alemede, L.C. and Erhuanga R.A. (2011). Replacement value of rubber seed meal for full fat soya bean meal on performance, carcass characteristics and blood parameters of broilers *.Nig J. Anim. Prod.38 (2): 34-45*

NRC, (1994). Nutrient requirements of poultry. In the nutrient requirement of farm animal. National Academy of Sciences, Washington, D. C. 9th revised edition

NRC/NAS (1980). National Research Council Committee on Dietary Allowances. Recommended Dietary Allowances 9th edn. National Academy of Science Press. Washington, DC. USA

Obioha, F.C. (1992) A guide to poultry production in the Tropics. Acena Publishing. Enugu, Nigeria.

Offiong, S.A. and Olomu J.M. (1990). .Effect of feeding raw, toasted, and cooked and autoclave full fat soyabean on the growth of broiler chicks. Trop. Agri. Trinidad, 3: 297-302.

Olomu, J.M. (2011). Plant protein source. Monogastric Animal Nutrition. Principles and Practices 2ed .A Jachem Publication. Benin City, Nigeria. 214-215.

Oluyemi, J.A., Robert, F.A., (2000). Poultry production in warm wet climate (2nded). Spectrum Books Limited, Ibadan, Oyo State, Nigeria.

Oyewusi, P. A., Akintayo, E.T.M. and Olaofe, O. (2007). The proximate and amino acid composition of defatted rubber seed meal. *Journal of Food, Agriculture and Environment. Vol. 5. (3 & 4): 115 -118. www.world-food.net.*

Park, Y.S.; Yoo, I.J.; Jeon, K.H.; Kim, H.K.; Chang E.J.; Oh, H.I (2003) Effect of various Eggshell Treatments on the Egg Quality during Storage. Asian-Aust.J.Anim. Sci. Vol. 16, 8:1224-1229

Pech, S. (2002). The evaluation of rubber seed as a fee supplement for pig production. Phnompenh Cambodia: Royal University of Agriculture. MSc Thesis.

Ravindran, V. (1995). Evaluation of a layer diet formulated from non-conventional feeding stuffs. Br. Poult. Sci., 36 (1): 165-70.

Stosic, D.D. and Kaykay, J.M. (1991). Rubber seeds as animal feed in Liberia. *World Animal Review* 39(3):29-39.