MARDI Res. Bull. 3, 1: (63–70)

PERFORMANCE OF LAYERS FED HIGH LEVELS OF BROKEN RICE AND TAPIOCA AS A DIRECT SUBSTITUTE FOR MAIZE

SYED ALI BIN S. ABU BAKAR, YEONG, S. W.
and SEET, C. P.

Accepted for publication on 18 March, 1975

RINGKASAN

Satu percubaan pemakanan telah dilaksanakan selama empat puluh minggu untuk menguji keupayaan ayam jenis telur yang diberi makan beras hancur dan ubi kayu mengganti jagong di dalam campuran makanan. Enam makanan percubaan, iaitu mengandungi 60 peratus (%) jagong sebagai kawalan "control", 30% jagong + 30% beras hancur, 60% beras hancur, 30% jagong + 30% ubi kayu, 60% ubi kayu dan 30% beras hancur + 30% ubi kayu telah digunakan. Kandungan campuran yang 40% lagi bagi tiap-tiap makanan adalah sama. Keputusan menunjukkan bahawa keupayaan bertelur bagi ayam-ayam yang memakan beras hancur adalah setanding dengan ayam-ayam yang memakan jagong. Keupayaan bertelur bagi ayam yang memakan 60% campuran ubi kayu adalah berbeza jauh ($P < 0.05$) dengan kumpulan-kumpulan yang memakan 60% jagong dan beras hancur. Didapati tidak ada perbezaan "significant" bagi kumpulan yang memakan 30% ubi kayu bercampur 30% jagong dengan kumpulan kawalan. Kekurangan xanthophyll di dalam makanan yang mengandongi 60% ubi kayu dan beras hancur menyebabkan kuning telur menjadi pucat, tetapi kesan ini boleh dibaiki jika xanthophyll tiruan dicampurkan bersama dalam makanan yang berkaitan.

INTRODUCTION

Maize, well accepted as a feedgrain for poultry, has been used by farmers and feedmillers in all corners of the world. Its nutritive value has been well-authenticated. It is rich in energy, but has a relatively low level of crude protein and essential amino acids. The incorporation of high levels maize in the diets creates no problem at all in the formulation of a balanced poultry ration. However, it was reported that in Peninsular Malaysia, maize could not be economically produced on a large scale because of certain major constraints like suitability of terrain and soils, climatic condition and high labour cost (CUNARD, 1973). Therefore at present large quantities of maize are imported by feedmillers for use in animal feeds.

Other local sources of energy for poultry are tapioca, surplus broken rice, sago and sorghum. Tapioca root *(Manihot utilissima* Pohl*)* is rich in energy, but has a very low protein and essential amino acid contents (*Table 1 and 2*). It has been reported that it also contains cyanogenic glycoside linamarin which caused depression in growth and low egg production in chicken (HUTAGALUNG, 1972; HILL, 1973). Other reports have shown that the performance of layers was not affected if fed below 20 per cent level as a direct substitute to maize (JALALUDDIN and YIN, 1972; HUTAGALUNG, 1972).

Broken rice was found to be comparable to maize in growth and feed efficiency when fed to broiler chicken (MOROMOTO, YOSHIDA and SOSHII, 1963; ALI, YEONG and SEET, 1972). SMITH (1948) reported that the performance of layers was not affected even when 75 per cent of whole grain maize was replaced by rice in the layer diet.

The objective of this experiment was to observe and explore further the relative performance of layers fed high levels of broken rice and tapioca as a direct substitute to maize in the layer rations. This will provide clues and guidelines for the follow up work to remedy any deficiency and deleterious effect arising from the feeding of high levels of broken rice and tapioca.

TABLE 1. CHEMICAL COMPOSITION OF TAPIOCA MEAL, WHITE POLISHED RICE AND MAIZE

	Tapioca Meal*			Polished Rice+	Maize+
	M	W	H		
Moisture %	11.8	10.0	11.0	11.0	14.0
Crude Protein %	2.8	3.2	2.3	7.3	8.8
Crude Fibre %	3.3	2.7	1.8	0.4	2.0
Ether Extract %	0.6	0.4	1.2	--	--
Ash %	3.1	0.92	1.0	--	--
Nitrogen-Free Extract %	78.4	82.7	82.0	-	--
Calcium %	0.15	0.06	0.45	0.04	0.03
Phosphorus %	0.09	0.09	0.40	1.42	0.27
ME Kca:/kg.		--	--	3,100	3,417

*(M) Chou and Muller (1972)
(W) Olson, Sunde and Bird (1969b).
(H) Hutagalung (1972)
(+) N. R. C. (1971)

MATERIALS AND METHODS

A randomised block experiment was used with four blocks and six treatments. Two hundred and sixteen pullets (commercial hybrid layers) were used. They were reared together from day-old to twenty weeks of age when they were singly caged in battery cages. Their individual performance with respect to the number of eggs laid and body weight were recorded till the end of twenty-seventh week of age. Twenty-four birds having similar performance were picked out each time and randomly allocated to six treatments in the four blocks. Nine birds were placed within each block as a treatment group.

The treatments comprised six experimental diets A, B, C, D, E and F (*Table 3*). The experimental diets were fed to the appropriate groups at the beginning of twenty-eight week. A two weeks adaptation period was given to all groups in order to remove the carryover effects of the previous diet. The trial was conducted for forty weeks, from the thirty-first to seventieth week of age.

Weekly feed intake, individual egg production records and weekly mean egg weight for each treatment group were taken during the experimental period. The body weights were recorded once before the start and at the end of the experiment.

TABLE 2. AMINO ACID COMPOSITION OF TAPIOCA, WHITE POLISHED RICE AND MAIZE

Amino Acids (%)	Tapioca (W)*	White Rice+	Yellow Maize+
Arginine	0.24	0.36	0.50
Cystine	0.01	0.09	0.09
Histidine	0.05	0.18	0.20
Isoleucine	0.02	0.45	0.40
Leucine	0.028	0.71	1.10
Lysine	0.036	0.27	0.20
Methionine	0.016	0.27	0.17
Phenylalanine	0.010	0.53	0.50
Threonine	0.022	0.36	0.40
Tryptophan	0.037	0.09	0.10
Tyrosine	0.010	0.62	..
Valine	0.030	0.53	0.40

(W) Olson, Sunde and Bird (1969b)
(+) N. R. C. (1971)

Table 6 shows that all groups gained body weight during the 40 weeks experimental period. The range between the highest gain (B group) and the lowest gain (C group) was only 108 grams. This small gain between groups is of no significant economic value, as far as the price of culled birds is concerned. In spite of the poor production the birds in E group sustained the body weight well throughout the period.

Egg Yolk Colour

During the first 14 weeks of the experimental period, weekly samples of eggs from groups A, B, C, D, E and F were broken and egg yolk colour readings were recorded. Artificial xanthophyll commercially known as "Carophyll" was then added to diets C, E and F which were completely devoid of maize at the rate of 1 g. per 100 lb. of feed. In the first treatment three different "Carophyll" materials, red, orange and yellow were added to rations C, E and F respectively for a period of 4 weeks. This was firstly done for the purpose of determining the effects of different colours on pale yolk. In the second treatment only "Carophyll" orange was added to C, E and F groups for a period of 8 weeks. The results of this study are given in *Table 7*.

TABLE 3. COMPOSITION OF EXPERIMENTAL LAYER RATIONS

Ingredients		Rations					
		A	B	C	D	E	F
1.	Maize	60	30		30		
2.	Broken rice	-	30	60	-	-	30
3.	Tapioca meal	-	–	-	30	60	30
4.	Rice bran	11	11	11	11	11	11
5.	Grass meal	2	2	2	2	2	2
6.	Soybean meal	15	15	15	15	15	15
7.	Fish meal	5	5	5	5	5	5
8.	Limestone powder	4.5	4.5	4.5	4.5	4.5	4.5
9.	Tricalcium phosphate	1.5	1.5	1.5	1.5	1.5	1.5
10.	Vitamin mix*	0.5	0.5	0.5	0.5	0.5	0.5
11.	Salt	0.5	0.5	0.5	0.5	0.5	0.5
	TOTAL	100.0	100.0	100.0	100.0	100.0	100.0
	Calculated value**						
	Crude protein (%)	16.50	16.27	15.90	14.88	13.26	14.58
	Crude fat (%)	5.23	3.80	2.60	3.53	1.96	3.33
	Crude fibre (%)	3.61	3.05	2.49	3.70	3.79	3.14
	Calcium (%)	3.71	3.73	3.75	3.75	3.79	3.77
	Phosphorus (%)	0.51	0.55	0.59	0.55	0.59	0.59
	ME (Kcal/kg)	2573	2478	2383	2582	2590	2478
	Methionine (%)	0.329	0.356	0.383	0.281	0.233	0.308
	Cystine (%)	0.292	0.211	0.238	0.242	0.191	0.215
	Lysine	0.927	0.948	0.996	0.888	0.849	0.909
	Tryptophan (%)	0.198	0.201	0.204	0.175	0.151	0.170
	Threonine (%)	0.656	0.638	0.620	0.561	0.465	0.543

*Commercial vitamin mix is used. Every 10 lb. of vitamin mix contains vitamin A 900,000 I.U., vitamin D_3 900,000 I.C.U., Riboflavin 2.0 gm., Panthothenic acid 3.2 gm., Niacin 10.0 gm., Choline 50.0 gm., vitamin B_{12} 4.0 mg.

**Calculated values are based on N.R.C. figures except tapioca.

RESULTS

TABLE 4. MEAN EGG PRODUCTION PERFORMANCE, FEED INTAKE AND FEED CONVERSION EFFICIENCY FOR 40 WEEKS PERIOD

Treatment Group	Egg Number (280 days)	Mean Percent Production	Mean Egg Weight (g)	Total Egg Mass (Kg)	Total Feed Intake (Kg.) (g/hen/day)	Feed Conversion Efficiency Kg. Feed/Kg. Egg
A	196.67* ab	70.24* ab	60.69	11.936	31.560(112.7)	2.64
B	204.75 a	73.10 a	60.14	12.314	32.360(115.4)	2.63
C	201.91 a	72.10 a	59.68	12.049	29.648(106.0)	2.46
D	189.70 bc	67.75 bc	59.16	11.224	30.740(109.8)	2.74
E	138.47 d	49.45 d	55.72	7.716	30.190(107.8)	3.91
F	183.05 c	65.40 c	59.50	10.892	31.010(110.7)	2.85

*Means on the same column having different italicised letters differ significantly ($P < 0.05$).

TABLE 5. MULTIPLE RANGE TEST ($P < 0.05$)

Treatment Group	(Egg number) ranked treatment mean	Number of mean	Significant studentized mean	Shortest significant range
B	204.7500	--	-	--
C	201.9167	2	2.772	10.8637
A	196.6667	3	2.918	11.4359
D	189.6944	4	3.017	11.8239
F	183.0556	5	3.089	12.1061
E	138.4722	6	3.146	12.3295
	Standard Error of mean = 3.92			

DISCUSSION

Since 60% basal maize diet (Treatment A) was used as a control, the results indicated that there were no significant differences in the egg number or percentage production between A and B, A and C, and A and D groups. Broken rice therefore can replace maize at a level as high as 60% in the layer diet. This further supports the finding of SMITH (1948) who incorporated rice even at a higher level of 75% in the ration. Feed conversion efficiency (EFC) was found to be in favour of 60% rice group compared to A or B groups.

Birds fed 30% maize + 30% tapioca (D group) laid seven eggs less than the control which was not statistically significant. It was noted that there was only a slight difference in EFC compared to control. It appears that there should not be a problem now to incorporate up to 30% level of tapioca in layer diet provided that the protein and amino acid is adjusted and balanced. Earlier work by JALALUDDIN and LEONG (1972) and HUTAGALUNG (1972) indicated that there were no significant differences in the performance of layers fed 20% tapioca as a direct substitute to maize in

TABLE 6. MEAN BODY WEIGHT INCREASE DURING THE EXPERIMENTAL PERIOD (g.)

Treatment Group	Mean Initial Body Weight	Mean Final Body Weight	Live Weight Change
Group A	1759	1831	+ 72
Group B	1748	1884	+ 136
Group C	1804	1832	+ 28
Group D	1807	1869	+ 62
Group E	1765	1874	+ 109
Group F	1846	1923	+ 77

TABLE 7. EFFECT OF CAROPHYLL ON YOLK COLOUR

Groups	ROCHE YOLK COLOUR FAN NO.*		
	Before Treatment	After Treatment 1	After Treatment 2
A	12	12	12
B	3	3	3
C+	1	14	12
D	3	3	3
E+	1	12	12
F+	1	3	8

*Yolk colour readings: 14 = red, 12 = orange, 8 = golden yellow, 5 = yellow, 3 = lemon yellow, 1 = pale yellow.

+Diets supplemented with Carophyll.

the layer diets. However, direct substitution of maize with tapioca at 60% level of the diet gave the worst result and it differed significantly ($P < 0.05$) with all the other groups, and the egg production was about 70% of that produced by the control group.

Birds from D group produced 6.6 eggs more than the F group, and this difference was not statistically significant. As the performance of birds fed 30% tapioca mixed with 30% broken rice or 30% maize diets was comparable, this again indicated that maize and rice has almost similar feeding values.

The mortality figures during the 40 weeks experimental period were identical for all the groups viz. 3 birds died or culled from each group. As birds from all the groups showed body weight increase, it could be presumed that the general health of the birds was not affected by toxic effect of linamarin in tapioca. It is possible that the cyanogenic glycosides present in tapioca roots has been reduced considerably during the process of drying and processing into chips, or adult birds on the other hand could tolerate the mild effect of linamarin. JALALUDDIN and YIN (1972) observed that adult hens seemed to be quite tolerant and maintained egg production when fed tapioca leaves with a high HCN content.

Lack of xanthophyll in the 60% broken rice and 60% tapioca diets has no adverse effect in the laying performance except for the yolk colour. This defect can however be remedied by supplementation of diets with artificial xanthophyll. The change in the egg yolk colour could be obtained after four or five days of feeding the supplements.

As the feed intake and the energy values of the tapioca and maize rations (A. D and E) did not vary greatly it seemed that the main causes of poor production would be attributed to marginal or low intake of protein and amino acids. Tapioca protein contains a very small quantity of sulphur-containing amino acid and a deficiency of methionine and cystine *per se* could be the major cause. The metabolisable energy value for broken rice ration was lower than maize as quoted in the N.R.C. figures, but it was rather surprising to note that the feed intake was lower and EFC was better in the rice than the maize group. It is possible that broken rice has a slightly higher metabolisable energy value than quoted. The improved feed efficiency could be due to the slightly higher lysine content in rice.

ACKNOWLEDGEMENT

The authors wish to thank Dr. Anuwar bin Mahmud, Director of MARDI, for his keen interest and support in this field of research and Dr. Kassim bin Ismail for his guidance and advice. The assistance and cooperation given by the Statistics Division in analysing the data, the Soil Division Laboratory staff for analysing the feedstuffs, and the supporting staff in Poultry Unit is highly appreciated. We extend our thanks to Roche Far East Ltd. for the supply of Carophyll used in the experiments.

SUMMARY

A 40 week feeding trial was conducted to test the performance of commercial layers fed high levels of broken rice and tapioca as a direct substitute for maize. Six experimental diets, viz. 60% maize diet as control, 30% maize + 30% broken rice, 60% broken rice, 30% maize + 30% tapioca, 60% tapioca, 30% broken rice and 30% tapioca, were used. The other 40% part of all the rations was constant. It was found that egg production performance of layers fed high levels of broken rice was comparable to maize. The performance of birds fed high tapioca (60%) diet was badly affected and differed significantly ($P < 0.05$) with the other groups. No significant difference ($P < 0.05$) was observed when 30% maize was replaced by 30% tapioca as compared to the control diet. Lack of xanthophyll in the high broken rice and tapioca diets caused the egg yolk colour to become pale, but this deficiency was corrected by the addition of artificial xanthophyll in the diets.

REFERENCES

ALI, S., YEONG, S. W. and SEET, C. P. (1973). Direct substitution of maize by broken rice in broiler diet. *MARDI Res. Bull., 1*: 37 40.

CHOU, K. S. and MULLER, Z. (1972). Complete substitution of maize by tapioca in broiler ration. *Proc. Aust. Poult. Sci. Conv.*, Auckland, N. Z. p. 149-160.

CUNARD, A. C. (1973). Towards agricultural import substitute. *Proc. 3rd MARDI Scientific Staff Conf. Serdang Dec. 17, 1973*, p. 2.

HILL, D. C. (1973). Chronic cyanide toxicity in domestic animals. Chronic Cassava Toxicity – *Proc. Inter-disciplinary Workshop* London, England, January, 1973, p. 105 111.

HUTAGALUNG, R. I. (1972). Nutritive value of tapioca leaf meal, tapioca root meal, normal maize, Opaque – 2 maize and pineapple bran for pigs and poultry. *Papers presented at the 17th Conference of the Malaysian Veterinary Association, Kuala Lumpur.*

JALALUDDIN, S. and YIN, O. S. (1972). Hydrocyanic acid (HCN) tolerance of hen. *Mal. Agric. Res., 1* : 77.

JALALUDDIN, S. and LEONG, S. K. (1973). Response of laying hens to low and high levels of tapioca meal. *Mal. Agric. Res., 2* 47 51.

MOROMOTO, H., M. YOSHIDA and SOSHI H. (1963). Comparison of nutritive value of eight cereals. *Bulletin National Institute of Japan 1*, : 24.

National Research Council (1971). Nutrient Requirements of Poultry Sixth edition. *National Academy of Sciences, Washington, D. C.*

OLSON, D. W., M. L. SUNDE and H. R. and BIRD, H. R. (1969a). The metabolizable energy content and feeding value of mandioca meal in diets for chicks. *Poultry Sci 48* : 1445 1452.

OLSON, D. W., M. L. SUNDE and BIRD, H. R. (1969b). Amino acid supplementation of Mandioca meal in chick diets. *Poultry Sci., 48* : 1949 1953.

SMITH, R. M. (1948). The use of rice and rice by-products in the laying ration. *Bull. Arkansas Agric. Expt. Stan., 478* : 1-30.