Growth performance of free-range village chickens fed dehydrated processed food waste

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Abstract

The effect of dehydrated processed food waste (DPFW) inclusion in the diets on the growth performance (feed intake, body weight gain, body weight change and feed conversion ratio) of free-range village chickens was investigated. Food waste collected from 20 different restaurants of Universiti Putra Malaysia Serdang Selangor was processed into DPFW containing 89.3% dry matter, 16% crude protein, 7.1% crude fat, 3.7% crude fiber, 7.4% crude ash, 3.07% NaCl, 1.56% Ca, 0.87% phosphorous and 4053 kcal/kg GE. A total of of 180 village chickens of the Arabian breed were randomly allocated into four dietary treatments of 0 (control), 20, 40 and 60% DPFW for 5-9 week grower and 10-14 week finisher periods with three replicates (15 birds for each replicate). The results showed that the highest feed intake in grower and finisher phases was observed in the control group by 634.0 g and 2,722.1 g, respectively, while the lowest was in 60% DPFW with 586.3 g for grower and 2,542.6 g for finisher phases ($P<0.05$). However, no significant difference was elucidated between control group and 20% DPFW in grower and finisher periods of 630.7g and 2,707g, respectively ($P>0.05$). Body weight gain and body weight change declined linearly with increasing levels of DPFW of more than 20% in the village chicken diets during both grower and finisher rearing phases. FAR increased ($P<0.05$) with increasing DPFW inclusion (of more than 20%) during the grower period. Accordingly, higher amount of DPFW of more than 20% in the diets decreased the consumption of nutrients and metabolisable energy by the birds and consequently, the chickens grew considerably less, leading the birds to apply a higher amount of the dietary energy and nutrients for maintenance. Feed conversion ratio was only influenced by increasing DPFW by more than 20% ($P>0.05$). In conclusion it seems that the dehydrated processed food waste could substitute 20% of formulated feed in grower and finisher phases of free-range village chickens without any adverse effects on growth performance.

Keywords: dehydrated processed food waste, free-range village chickens, growth performance

Introduction

Dramatic increase in world human population need high quality and versatile foodstuffs mainly protein sources, while rising levels of income have resulted in higher quality food preference and elevated living standards have created a tremendous demand for animal products (FAO, 2006). Accordingly, the recent big expansion in animal protein demand has been largely met by the rapid worldwide evolution in livestock production, especially poultry. As a result, the world meat economy has araisen quickly in the global livestock meat production. Meanwhile, although fast growth rate has been effective in decreasing the rearing period to reach market weight (Sulistiyanto *et al*., 1999), there are also been related serious problems with this system, which have led to attract attentions to alternative rearing systems and chicken breeds that are deprived from these serious issues (Bartussek, 1999). Due to problems caused by industrialized rearing systems, growing awareness of human health, chicken welfare, nutritional concerns and chicken diseases, attentions are attracted to specialty markets for free-range system and village chicken types more suitable for this system. The main characteristics of this innovative system are a definite standard better care to animal welfare (stocking mass, availability of perches, free-range zones), no regular use of growth promotants, non-use of animal offal, potential production of high quality meat products of many other flavors. However, despite of all benefits which a free-range system offers, production and productivity remain well below potential. Accordingly, low productivity is caused by poor available nutrition required as a consequence of lack of supplementary feed (Islam and Jabbar, 2003). The main nutritive source of free-range village chickens in many developing regions is food scavenged containing anything edible found in the surrounding environment. Population of scavenging chickens is most likely to increase until the capacity of the scavenging source is insufficient, due to the fact that the feed consumed is under the nutritional needs of the chickens (Sonaiya, 2004). Therefore, these birds face quantitative and qualitative food shortage particularly in poor agricultural or household residue environment. To overcome this problem some farmers give conventional feedstuff such as pelleted feed to free-range chickens to supplement their scavenging sources in order to lead them to meet their nutritional requirements and produce high output. However, the common commercial feedstuffs are not economically attractive for farmers to provide for their chickens (Dolberg, 2001).

Thus, in order to allow indigenous chickens to contribute effectively to food security improvement, it is necessary to increase their productivity by decreasing the use of commercial feed through supplementation with available and nutritive local feed resources (Sonaiya and Swan, 2004). To overcome this problem researchers have examined different feed sources such as food waste. Official publications and bulletins from USDA-APHIS confirm that using food waste as feeds for livestock has the great nutritional and economic potentials to assist producers increase the livestock production (USDA-APHIS, 1995). Westendorf (2000) stated that food waste or leftover food as an available, nutritional and cost effective resource, could be used as a possible economical alternative source to supplement nutrient intake for animals. Food wastes are precious supplies, which can be reutilized as new valuable foodstuffs through animal production. Recycling and reusing leftover food into animal feed is vital because it can contribute to not only reducing import of feed ingredients but also lessening environmental pollution (Westendorf *et al*., 1998).

The initial purpose for including non-typical feeds or food waste is to escalate profitability by employing low cost dietary ingredients. The usage of unused food should be fitted to animal requirements for exclusive production goals (Walker and Wertz, 1994). Feeding processed dehydrated food waste may be an efficient part of supplementary diet associated with conventional feedstuff for free-range chickens and this may decrease amount of commercial feedstuff, which may allow small-scale farmers to contribute effectively in livestock production by decreasing input and increasing output of their production. Therefore the present study was conducted to determine the economical, practicable and scientific method of processing, dehydrating and defatting food waste in order to supplementing the diet of village chickens by small-scale farmers, to evaluate the composition of processed dehydrated food waste and its nutritive values and to investigate the effects of different dietary inclusions of processed dehydrated food waste as a supplementary feed on growth performance of village chickens.

Materials and Methods

Preparing and Processing of Food Waste

Food waste was collected twice daily from 15 different restaurants of Universiti Putra Malaysia, Serdang, Selangor within a three-month period. All food waste were processed and used as an ingredient in formulating the diets of the chickens used in this study. The food-waste were mainly uneaten food remains and plate scrapings made up of residues of cooked rice, noodle, breads, cereals, vegetables, different types of meat, oils, chicken and fish bones, potatoes, tomatoes, peas and some food additives. For pre-treatment, the food waste was grounded and observed manually to remove unsuitable components which were separated manually from the food waste. All leftover foods were mixed manually to ensure that the composition of waste was homogeneous to prepare it for whole rearing period. Accordingly, the amount of fat content of the food waste was reduced by soaking the food waste in near boiling water (<100^{o}C) for 10 min using 0.2 mm net strainer. The practical soaking time in boiling water was achieved after examining different periods of soaking time and analyzing fat content of food waste in each trial (Table 1). As laboratory analysis revealed, the suitable time was 10 min of soaking and soaking more than 10 min would turn the food waste materials into mashed product, which was a barrier for further processing. The waste was then dehydrated directly under the sun through spreading on portable drawer-like nets and to protect from rain plastic covers were placed above the portable nets and covered with cotton sheets to avoid being eaten by wild birds for 48 h. In the next step, dried food waste was ground through 1-mm screen grinding machine and packed in clean dry airtight containers and stored in a dry place until feeding. Dehydrated processed food waste (DPFW) was slightly greasy to a touch, brownish in color and had a mild aroma. Samples of DPFW were collected for laboratory analysis by AOAC (1990) methods. Representative samples of the DPFW products were analyzed for dry matter, crude protein, crude fat, crude fiber, ash, P, NaCl, and gross energy (Table 2).

Table 1. Mean crude fat of food waste

Soaking time	Crude fat (%)
Dried samples (not soaked)	20.62 ± 0.2
5-min soaking	12.49 ± 0.9
10-min soaking	7.16 ± 0.6

Table 2. Chemical composition of five DPFW samples

Items	Mean ± S.D.
Dry matter	89.3 ± 1.3
Crude protein	16.0 ± 1.2
Crude fat	7.1 ± 1.0
Crude fiber	3.7 ± 2.1
Crude ash	7.4 ± 1.1
NaCl (%)	3.1 ± 0.4
Calcium	1.6 ± 0.5
Phosphorus	0.9 ± 0.1
GE* (kcal/kg)	4053.5±1.0

*GE: gross energy

*Feeding and Rearing Procedure*s

One hundred and eighty uniform grower village chickens of the Arabian breed were purchased from a breeder farm in Melaka Malaysia. From one day old to 4 wk of age the chicks were fed with high protein (23%-24% CP) starter commercial broiler feed. The chickens at four wk of age with an average body weight of 300±10g were randomly allotted to four treatments in a complete randomized design. Each treatment was replicated three times in individual pens with 45 birds per treatment divided into three replicates of 15 birds per replicate. The free range area was partitioned into 12 compartment pens measuring 6 m x 10 m, which each pen surrounded by three m height net and each bird was given at least two m of foraging space according to European Union Commission (2000). To determine and evaluate growth performance and meat quality of birds fed DPFW as a supplementary feed, four treatments were allocated for grower phase from 5 to 9 wk and finisher phase from 10 to 14 wk of age periods. The treatments were Treatment 1 (control group): 100% conventional feedstuff (CFS), Treatment 2: 20% DPFW and 80% CFS, Treatment 3: 40% DPFW and 60% CFS and Treatment 4: 60% DPFW and 40% CFS. Formulation of the diets was according to the chemical analyses of the DPFW of 3,000 kcal /kg and 20% crude protein for grower phase and 3,100 kcal/kg and 18% crude protein for finisher phase following the guideline of NRC (1994) (Table 3). Feed and water were provided twice daily *ad libitum*. Growth performance which included feed consumption, live body weight, body weight change and feed conversion ratio were recorded as group per replicate and individually each week. Two birds were reared separately in individual cages in the free range area to record accurate growth performance measurements.

The birds were weighed once a week. The data were recorded from the beginning of the experiment with four wk old birds until 14 wk old. Body weight gain was calculated as body weight at the end of each week deducted from body weight at the beginning of that week. Body weight gain was also measured as percentage of the final weight at the end of each week. Feed consumed was measured and recorded daily in the morning before the morning feeding by weighing the given feed and the residual feed in the feeders of separated birds in individual cages. FCR was calculated to indicate the increase in body weight by amount of feed consumed by the birds as weekly feed intake (g) / body weight gain (g).

Statistical Analysis

Analysis of variance for a completely randomized design was performed using the GLM procedures of SAS (1990). The model contained the outcomes of diet and nutrient factors. For each experiment, means were separated using Fisher's Protected Least Significant Difference Test. Significance was confirmed at P<0.05.

Table 3. Composition of experimental diets

Ingredients	CP (%)	ME Kcal/kg	Grower 5-9 wk Control	20% DPFW	40% DPFW	60% DPFW	Finisher 10-14 wk Control	20% DPFW	40% DPFW	60% DPFW
Food waste	16	3600	0	20	40	60	0	20	40	60
Corn meal	7.5	3350	44.8	29.9	16.6	0	54.2	37.7	22.4	4.5
Soybean	35	2230	36.7	30	23	15	30.2	22.8	15	7.7
Fish meal	55	2820	5	5	5	5	5	5	5	5
Rice bran	12	2150	7	11	13.5	19.2	4.5	10.7	16	22
Sunfolwer oil		8800	4.1	2.6	1	0.2	4.1	2.7	1	0.2
DCP			0.8	0.7	0.5	0.2	0.5	0.3	0.2	0.2
DL-Methionine			0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Salt			0.31	0.2	0.07	0	0.31	0.2	0.06	0.06
Limestone			0.9	0.2	0	0	0.8	0.2	0	0
Vitamin premix*			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Mineral premix			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total			100	100	100	100	100	100	100	100
Calculated analysis:										
ME (Kcal/kg)			3000.5	3000.9	3028.3	3065.9	3094.0	3100.0	3009.8	3104.0
CP (%)			19.9	20.01	20.7	19.9	18	18.4	18	18.02
Ca			0.89	0.98	1.24	1.56	0.77	0.88	1.16	1.54
Na			0.16	0.18	0.19	0.22	0.16	0.18	0.19	0.25
K			0.91	0.73	0.55	0.34	0.81	0.61	0.41	0.21
Methionine			0.58	0.52	0.46	0.39	0.55	0.49	0.42	0.36
Lysine			1.39	1.19	0.98	0.76	1.22	1.02	0.8	0.59
Cysteine			0.4	0.33	0.26	0.18	0.37	0.3	0.22	0.14

*Vitamins

Growth Performance

The effects of substitution level of DPFW in formulated feed on feed intake of village chickens are shown in Table 4. The average weekly feed intake was significantly lower in chickens fed 60% DPFW than the other groups (P< 0.05), while it was the highest in the control group (without DPFW) during the rearing period. However, there were no significant differences between groups fed diet containing 0%, 20% and 40% DPFW (P>0.05) until 12 wk of age. Meanwhile it became significantly lower in the group fed 40% DPFW compared with other treatment groups in last two wk of rearing period (P<0.05).

As presented in Tables 5 and 6 the highest body weight gain (BWG) and body weight change (BWCH), respectively, were observed in the control group followed by 20% DPFW treatment group with no significant difference between them (P>0.05), whereas there was significant difference among 40% and 60% DPFW treatment groups compared with the control and 20% DPFW group ($P<0.05$). Exceptionally significant improvement in body weight gain and body weight change was observed in treatment group 40% DPFW at 11 wk of age, but it did not continue until the end of rearing period. The lowest weekly body weight gain and body weight change during rearing period without any change was observed in treatment group 60% DPFW followed by treatment group 40% DPFW with significant difference ($P<0.05$) compared with the control group.

Table 4. Effect of supplementing dehydrated processed food waste on feed intake of village chickens

Week	Diet				
	Control	20% DPFW	40% DPFW	60% DPFW	SEM
5	242.3[a]	240.7[a]	238[a]	230.7[b]	1.677
6	292.3[b]	308.6[a]	307.3[a]	294.5[b]	2.511
7	345.0[a]	347.0[a]	344.3[a]	334.5[b]	1.889
8	386.0[a]	386.6[a]	381.6[a]	359.5[b]	3.436
9	424.1[a]	424.5[a]	421.0[a]	399[b]	3.38
10	458.1[a]	457.0[a]	451.6[a]	432.6[b]	3.404
11	500.4[a]	501.3[a]	492.0[a]	467.7[b]	4.267
12	539.5[a]	532.4[a]	529.3[a]	508.5[c]	3.678
13	589.9[a]	585.8[a]	571.3[b]	547.3[c]	5.253
14	634.0[a]	630.7[a]	619.3[b]	586.3[c]	5.805

Table 5. Effect of supplementing dehydrated processed food waste on body weight gain (BWG) of village chickens from week 5 to week 14

Week	Diet				
	Control	20% DPFW	40% DPFW	60% DPFW	SEM
5	83.3[a]	82.1[a]	79.0[b]	77.3[b]	0.776
6	104.4[a]	104.4[a]	99.6[b]	95.3[c]	1.226
7	109.0[a]	109.0[a]	105.0[b]	100.6[c]	1.083
8	117.0[a]	116.0[a]	112.3[b]	104.3[c]	1.534
9	122.0[a]	122.0[a]	117.3[b]	111.6[c]	1.332
10	128.3[a]	127.6[a]	124.3[b]	116.0[c]	1.509
11	136.0[a]	136.0[a]	132.0[a]	122.6[b]	1.729
12	142.0[a]	140.0[a]	134.3[b]	128.0[c]	1.676
13	151.0[a]	149.3[a]	141.0[b]	132.3[c]	2.264
14	158.0[a]	156.0[a]	149.3[b]	137.0[c]	2.490

[abc]Means with different superscripts in the same row differ significantly at $P<0.05$; SEM: Standard error of means

Table 6. Effect of supplementing dehydrated processed food waste on body weight change of village chickens from week 5 to week 14

Week	Diet				SEM
	Control	20% DPFW	40% DPFW	60% DPFW	
5	383.3[a]	382.1[a]	379[b]	377.3[b]	1.376
6	487.7[a]	486.5[a]	478.6[b]	472.6[c]	3.544
7	596.7[a]	595.5[a]	583.6[b]	573.2[c]	5.452
8	713.7[a]	711.5[a]	695.9[b]	677.5[c]	8.366
9	835.7[a]	833.5[a]	813.2[b]	789.1[c]	10.719
10	964[a]	961.1[a]	937.5[b]	905.1[c]	13.658
11	1100[a]	1097.1[a]	1069.5[a]	1027.7[b]	16.923
12	1242[a]	1237.1[a]	1203.8[b]	1155.7[c]	20.051
13	1393[a]	1386.4[a]	1344.8[b]	1288[c]	24.143
14	1551[a]	1542.4[a]	1494.1[b]	1425[c]	28.849

[abc]Means with different superscripts in the same row differ significantly at P<0.05; SEM: Standard error of means

As Table 7 demonstrates, the average FCR showed no significant (P > 0.05) difference among birds in the control group and treatment with 20% DPFW for the whole rearing period. Feed conversion ratio was poor and significantly increased when DPFW was added up to 60% (P<0.05). The least FCR was showed by the control group.

Table 7. Effect of supplementing DPFW on feed conversion ratio of village chickens

Week	Diet				
	Control	20% DPFW	40% DPFW	60% DPFW	SEM
5	2.90[c]	2.93[b]	2.95[b]	2.98[a]	0.009
6	2.95[c]	2.95[c]	3.04[b]	3.09[a]	0.018
7	3.17[c]	3.18[c]	3.25[b]	3.32[a]	0.019
8	3.30[b]	3.33[b]	3.40[a]	3.44[a]	0.018
9	3.47[c]	3.48[c]	3.55[b]	3.58[a]	0.013
10	3.57[c]	3.58[c]	3.65[b]	3.73[a]	0.020
11	3.68[c]	3.68[c]	3.72[b]	3.81[a]	0.017
12	3.80[c]	3.80[c]	3.87[b]	3.97[a]	0.021
13	3.91[c]	3.92[c]	4.00[b]	4.13[a]	0.027
14	4.01[c]	4.04[c]	4.16[b]	4.28[a]	0.033

[abc]Means with different superscripts in the same row differ significantly at P<0.05; SEM: Standard error of means

In the total rearing period no significant difference (P>0.05) was observed in feed intake, body weight gain and feed conversion ratio between control and treatment group

20% DPFW, while there were significant differences in feed intake, body weight gain and feed conversion ratio in 60% DPFW and 40% DPFW treatment groups compared with the control group and 20% DPFW group. Accordingly, during the whole rearing period, the feed intake and weight gain were lower while the FCR were higher linearly with increasing inclusion levels of DPFW in 40% DPFW and 60% DPFW groups compared with control and 20% DPFW groups (P<0.05). The lowest feed intake and body weight gain and highest FCR belonged to 60% DPFW group, followed by 40% DPFW with significant difference (P<0.05), while the highest feed intake and body weight gain and lowest FCR was recorded in the control group followed by 20% DPFW with no significant difference (P>0.05) between them (Table 8).

Table 8. Effect of DPFW on growth performance of village chickens in grower and finisher phases (5-14 weeks)

Parameters[1]	Diet				SEM
	Control	20% DPFW	40% DPFW	60% DPFW	
FI	4412.4[a]	4415.1[a]	4363.0[b]	4162.6[c]	31.49
BWG	1251.1[a]	1242.5[a]	1194.3[b]	1125.3[c]	15.16
BWCH	1551.0[a]	1542.4[a]	1494.1[b]	1425.0[c]	28.85
FCR	3.52[c]	3.55[c]	3.65[b]	3.69[a]	0.036

[abc] Means with different superscripts in the same row differ significantly at P<0.05; SEM: Standard error of means
[1]FI Feed intake, BWG Body weight gain, BWCH Body weight change, FCR Feed conversion ratio

The chemical composition of DPFW was comparable in nutritive values to those of conventional feedstuffs (NRC, 1994). However, the differences in growth performance among treatments might be associated with the composition and/or the amount of DPFW intake. The highest feed intakes in grower and finisher phases were observed in the control group and treatment group 20% DPFW, respectively, while the lowest was treatment group 60% DPFW during grower and finisher phases. However, no significant difference (P>0.05) was elucidated between control group and treatment group 20% DPFW in grower and finisher phases. This showed that by increasing more than 20% DPFW in the diet, feed intake decreased linearly, expressing that chicken performance mostly depended on the intake of DPFW and it might be due to less favorable rations of DPFW (more than 20%) and its high fiber content compared with conventional feedstuffs. This could also be due to the taste of DPFW, which did not have a positive effect on the appetite of the birds, and they did not show willingness to consume it in higher proportion (more than 20%). Consequently, the effects of substitution level of DPFW for formulated feed on body weight gain and body weight change of free-range village chickens showed a decline by supplementing more than 20% of DPFW during both grower and finisher rearing periods. As a result, birds grew expressively less, hence spending a higher proportion of the dietary energy and nutrients for maintenance. During the grower period, FCR increased (P<0.05) with the increasing DFWP inclusion. The highest FCR was treatment group 60% DPFW, similar with the findings of Chen *et al.* (2007). Compared with grower period, at finisher phase there was no significant difference between control group and treatment group 20% DPFW (P>0.05). Feed conversion ratio seemed to be influenced by increasing DPFW when this was imposed by more than 20% (P>0.05).

According to these findings, the dehydrated processed food waste could substitute up to 20% in free-range village chickens rations without any adverse effect on growth performance of the birds. It was because there was no significant difference in feed intake, gain weight and FCR compared with control group and it showed the nutritive quality and flavor of feed supplemented with 20% DPFW was similar to the control group. However higher levels of DPFW in the diet (more than 20%) caused reduction in weight gain and increase in FCR of free-range village chickens. However, the results of these experiments support and determine new, practicable and economical way of processing food waste with limited equipment for small scale farmers and also can help the environment by reusing food waste. These outcomes explain that human leftover food represent a precious supply that is an efficient nutritive source which can replace certain amount (up to 20%) of conventional feedstuffs, such as soybean and corn, in free-range chicken diets. Also they indicate that the free-range villages chickens have a great potential to consume food wastes as they have the capability to adjust to diverse nutrient concentration. According to mortality rate (less than 2.5%), caused by predators and hot weather (not due to lack of nutritive feedstuff), this research has proven that the dehydrating and processing human leftover food offers a safe and reliable feedstuff for the birds. This research confirms that DPFW does have nutritional value as indicated by the overall nutrient profile from DPFW-fed village chickens and it may be of adequate quality to maintain or improve growth performance of free range village chickens. Thus, since this by-product is economical and readily available and its processing is easy and practical, it can be offered to small-scale farmers to substitute certain amount of DPFW (20%) with conventional feedstuff which may help them to contribute effectively in chicken meat production. However it requires further investigation for different rations of leftover food as well as differing methods of processing it and also health protection performance which should be examined and amended in order to be certified for use as valuable nutritive supplementary feedstuff.

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