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Effects of inclusion of fermented cafeteria food leftover with commercial feed on production performance of Sasso T_{44} dual-purpose chickens

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Target Audience: *Animal nutritionist, Poultry farmers and Researchers*

Abstract

A feeding trial was conducted to evaluate and compare the effects of inclusion of fermented cafeteria food left-over (FCFL) in commercial ration on dry matter intake, growth performance, feed conversion ratio, carcass characteristics and bio-economics of production of Sasso T_{44} dual- purpose chickens. One hundred and eighty day-old unsexed broiler chicks were used for this experiment. Four treatment groups with three replicates, each having 15 animals per pen were employed. The experiment was conducted for 7 weeks after two weeks of adaptation period. Different levels of inclusion of FCFL (in percent) in concentrated commercial ration (T1: 0%; T2: 17%; T3: 34% and T4: 50%) were used in the four treatment groups. The experiment was arranged in a completely randomized design. Chicken Weight was taken at start and at weekly interval during the experiment. At the end of the experiment, 4 birds (2 males and 2 females) each were selected and sacrificed to evaluate carcass characteristics. To determine net return; partial budget analysis procedure was employed. Feed conversion ratio (FCR) and body weight gain were not significant ($P>0.05$) during starter, finisher, grower and the entire experimental period among treatments. Significant difference ($P<0.05$) was not observed among the carcass traits (slaughter wt., dressing percentage, eviscerated carcass, drumstick, thigh, breast meat, heart, liver, gizzard, skin, back, wing and neck). The highest net return was observed in T_4 (6774.3) followed by T_3 (6616.7), T_2 (6495.7) and T_1 (6343.5). The score of chicks' sale to feed cost ratio was also increased from T_1 to T_4. This shows that as the inclusion level of FCFL in the ration increased, the feed cost decreased. Therefore, inclusion of FCFL up to 50% in broiler ration is economical.

Key words: *Sasso T_{44}, Cafeteria food leftover, Growth performance, Feed intake, Carcass traits*

Description of Problem

Ethiopia has large population of chickens, estimated to be 56.53 million [7]. The proportion of native chickens of non-descriptive breed, hybrid of chickens and exotic breed of chickens mainly kept in urban and peri-urban areas are 94.31%, 3.21% and 2.49%, respectively [1,2]. The population increased significantly in last half decade as it was 48.89 million in year 2011 [2]. Majority of these chickens are maintained under a traditional system with little or no inputs for housing, feeding or health care. The most dominant chicken types reared in this system are local ecotypes, which show a large variation in body composition, color, comb type and productivity [3].

In Ethiopia, the availability and cost of feed is one of the major limitations to poultry production because of shortage of cereal grains, protein sources, vitamins and mineral supplements required for formulating balanced poultry rations. Feed cost generally constitutes about two third of the total production cost, depending on the geographical location, season and country [4]. The ever-rising prices of feed ingredients are the major determinant for the reduction of profit margins in poultry farming. The most appropriate strategy for developing poultry production in tropical countries like Ethiopia is to develop poultry feed from locally available conventional ingredients to make it cost effective. Use of unconventional feed materials to reduce feed cost could be a promising approach to enhance profit in poultry farming. Cafeteria food-leftover is one of the best options [5, 6] as well as protecting the environment against pollution from the cafeteria food leftover. Fermentation of the cafeteria food leftover is essentially required to prevent spoilage and its incorporation as animal feed. However, the inclusion of fermented cafeteria food leftover (FCFL) in commercial poultry feed on performance of Sasso T_{44} dual-purpose chicken under Ethiopian condition has not been investigated. On the other hand, experiences of other countries showed options and benefits in the use of available feed resources in poultry business [7-14]. Similarly, various research findings indicated safety issues of the various feed trial options [15-19]. Therefore, this study was designed to evaluate the feeding value of students' FCFL and its inclusion in commercial poultry feed on the performance of Sasso T_{44} broiler chickens under Ethiopian conditions.

Materials and Methods

Description of the Study Area

The experiment was carried out at College of Veterinary Medicine, Mekelle University. It is located 783 km North of Addis Ababa at 39° 29`E and 13° 30` N at an altitude of 2000 meter above sea level. The mean annual rainfall is 619mm, which is bimodal with short rainy seasons occurring from March to May and from mid-September to February. The annual minimum and maximum temperatures are 11.8°C and 29.9°C, respectively [20].

Ingredients and Experimental Rations

The feed ingredients used in the formulation of the experimental poultry rations were FCFL from Mekelle University student's cafeteria, commercial rations and soybean meal. The cafeteria food leftover was collected, fermented, sun -dried, ground and packed. Nutritive analysis of representative samples of feed the ingredients was determined. Four treatment rations were formulated using Win Feed software program to meet the nutrient requirements of the birds (Table 1). This formulation was based on the results of nutritive analysis of the feed ingredients for energy and nitrogen.

Table 1: Proportion of feed ingredients used in starter, grower and finisher rations (%)

Ingredients		Dietary Treatments T1	T2	T3	T4
Starter Phase: (2-3 week)	Commercial feed	80	58	36	15
	FCFL	0	17	34	50
	Soybean meal	20	25	30	35
		100	100	100	100
Grower Phase: (3-5 week)	Commercial feed	90	68	46	25
	FCFL	0	17	34	50
	Soybean meal	10	15	20	25
		100	100	100	100
Finisher Phase: (5-8 week)	Commercial feed	97	75	53	32
	FCFL	0	17	34	50
	Soybean meal	3	8	13	18
		100	100	100	100

Dried FCFL was fed to poultry after mixing with other ingredients, especially with protein feeds like soybean because it has high energy and less protein. Detailed preparation procedure for FCFL was as follows:

Ingredients and Their Quantities

Bikil (malt)	1.8 kg
Gesho (buckthorn)	1.8 kg
*Cafeteria food leftover	4 plastic containers each contains 250 Liter
Water	40 liter

* = leftover collected from dishes containing various nutrients depending up on daily schedule

Procedure of FCFL Preparation

1. 1.8kg of malt and 1.8kg of buckthorn were mixed with 4 liter of water in one container to prepare culture.
2. The mixture was kept for three days to prepare culture.
3. Four plastic containers each contains 250 liter were set to prepare sub-culture.
4. Each container was filled with cafeteria food leftover up to 200 liter.
5. The culture was equally distributed into the 4 prepared containers.
6. Forty liters of water was added in each container.
7. The ingredients were mixed properly and left for fermentation for a minimum of three days.
8. After three days, the sub-culture containers were opened and the contents were sun dried over plastic sheets.
9. The dried contents were ground and packed.

Experimental Chicks and Management

The experimental pens, waterers and feeding troughs were cleaned and disinfected before onset of experiment. A total of 180 day -old unsexed Sasso T_{44} dual -purpose broiler chicks with uniform body weight were randomly assigned to the 12 pens with each pen consisting of 15 chicks per replication and three replications for each of the four treatments. The chicks were vaccinated against Newcastle disease on day 8 and day 21. The chicks were habituated to the environment and fed a starter ration for the first two weeks. Feed was offered *ad libitum* and water was available throughout the experimental period. Feed refusal was collected and weighed every other day at 7:00 am.

Experimental Design and Treatments

A completely Randomised Design was used for this experiment with four dietary treatments each with three replications (Table 2). A total of 180 birds were randomly distributed to 12 pens and three of the pens received the same diet which was allocated to the pen.

Table 2: Treatment groups of the experiment

Treatments	Replications	Birds per replications
T1 (0 % FCFL)	3	15
T2 (17 % FCFL)	3	15
T3 (34 % FCFL)	3	15
T4 (50 % FCFL)	3	15
Total	12	180

FCFL- fermented cafeteria food leftover; T-treatments

Measurements and Observations

Nutritive Analysis

Samples were taken from each of the feed ingredients and analyzed for dry matter (DM), nitrogen content (N), ether extract (EE), crude fiber (CF) and ash using the Weende analysis method [21] and crude protein (CP) was determined by multiplying nitrogen by 6.25, and Metabolizable energy (ME) as follows:

ME (Kcal/kg DM) = 3951 + 54.4 EE – 88.7 CF – 40.8 Ash

Feed Intake

Mean daily dry matter intake was determined every day by subtracting the amount offered and left over collected. Mean daily DM intake per bird then was computed as

$$\text{Mean daily DM intake} = \frac{(\text{Feed offered}) - (\text{Left over collected})}{\text{Number of chicks}}$$

Carcass Yield Characteristics

At the end of the experiment, four birds (two males and two females) were randomly selected from each replication (12 birds per treatment) and starved for 12 hours, weighed and slaughtered for carcass evaluation. After slaughtering, the birds were de-feathered, eviscerated to obtain carcass. Edible and non-edibles offal were weighed and recorded as per standard procedure [22-23]. Dressing percentage was calculated as percent of live weight and eviscerated carcass. Eviscerated carcass weight was determined after removing blood, feather, shank, head, heart, liver, gizzard, kidneys, lung, pancreas, crop, pro-ventricles, small and large intestines and urogenital tracts. The eviscerated percentages were determined as the proportion of eviscerated weight and slaughter weight multiplied by 100. From eviscerated carcass, drumstick and breast meat were separated and weighed, then their weight were divided by slaughter weight and multiplied by 100 to determine their percentage proportion to the carcass.

Partial Budget Analysis

To estimate the net economic gain or loss as a result of inclusion of FCFL in broilers rations, the partial budget was analyzed taking into consideration the feed cost as a variable cost and sale of broiler meat as an economic return.

The marginal rate of return was calculated, taking into consideration the change in net return and total variable cost as follows:
MRR = ΔNR/ΔVC*100
The net return was calculated as:
NR = TR – TVC Where:
NR = Net return, TR = Total return, this is sale of chicks, TVC = Total variable cost, feed cost. Feed cost per live weight gain was also calculated as follows as an indicator of cost and biological efficiency.

$$\text{Feed cost per live weight gain} = \frac{\text{Cost of feed consumed (Birr)}}{\text{Live weight gain (kg)}}$$

Data Analysis

Data was analysed using SAS computer program [24]. Analysis of variance was used to detect the existence of significant differences among the treatment means. Besides, the Tukey's Multiple Range Test was used to locate treatment means that was significantly different from one another. The following Model was used for the experiment [25].

$Yij = \mu + Ti + Eij$

Where; -Yi - is the response variable, μ - is the overall mean, Ti - is the treatment effect, and Eij is the random error.

Ethical Consideration

Ethical clearance and approval was obtained from the institutional review board of Mekelle University College of Veterinary Medicine.

Results and Discussions

Nutrient concentrations of FCFL

Results for nutritive analysis of experimental feed are shown in Tables 3 and 4, respectively. The analysis revealed high metabolizable energy, EE and ash, and low CP concentrations from FCFL as compared to previous findings such as 3807.46 ME, 2.35% EE, 3.76% ash and 17.46% CP [26]. Furthermore, CP (%) and ME were found slightly higher than the results of Tamasgen [27], who reported 9.02% CP and 4029.48 ME although CF%, EE% and Ash% contents were lower than his report [27], who reported 3.62% CF, 13.13% EE and 7.7% ash. The energy and protein contents of soybean meal used in the current study were 39.79% CP and 3853.97 kcal/kg DM ME, which is comparable with Amene and his colleagues [28] who reported 39.04% CP and 3710.95 kcal/kg DM ME. The energy and protein contents of commercial feed used in the present study was 18.25 %CP and 3816.06 kcal/kg DM ME, from which CP is similar with that of the National research council (NRC) recommended range [29].

Table 3: Nutritive composition of ingredients used in formulation of dietary treatment rations

Ingredients	Nutritive composition (%)					
	DM	CP	CF	EE	Ash	ME (Kcal/kg DM)
Commercial feed	90.13	18.25	2.82	5.17	4.07	3816.06
FCFL	94.04	11.72	0.58	8.66	4.9	4170.74
Soybean meal	92.9	39.79	5.2	11.03	5.78	3853.97

Table 4: Nutritive compositions of experimental feeds

Feeds		Nutritive composition (%)					
		DM	CP	CF	EE	Ash	ME (Kcal/kg DM)
Starter	T1	90.7	22.56	3.3	6.34	4.41	3823.64
phase:	T2	91.5	22.53	3.03	7.23	4.64	3885.85
	T3	92.3	22.5	2.77	8.12	4.86	3948.02
	T4	93.1	22.52	2.52	8.97	5.08	4006.67
Grower	T1	90.41	20.4	3.06	5.76	4.24	3819.85
phase:	T2	91.21	20.37	2.8	6.64	4.47	3882.04
	T3	92.01	20.34	2.53	7.53	4.69	3944.23
	T4	92.78	20.37	2.3	8.38	4.91	4002.88
Finisher	T1	90.21	18.9	2.9	5.35	4.12	3817.20
phase:	T2	91.02	18.86	2.63	6.23	4.35	3879.39
	T3	91.82	18.83	3.37	7.12	4.58	3941.58
	T4	92.60	18.86	2.13	7.97	4.8	4000.22

Dry Matter Intake

The dry matter intake (DMI) during the starter phase is in Table 5. There was highly significant difference ($P<0.001$) in daily and total DMI among the treatment groups. There was increasing trend of total and daily DMI with increasing level of FCFL in the ration. This increment of feed intake may be due to the physical form of the test feed (denser than commercial bird ration) and has low fiber content than commercial rations. The higher nutrient intake of Sasso T_{44} chickens with the increasing proportion of FCFL was not in agreement with Halima [26], who indicated decreasing of feed intake with increased amount of dried cafeteria left-over. However, the current result agrees with finding of Tamasgen [27], indicating that increasing substitution level of dried food leftover up to 60% increased feed intake.

Table 5: Dry matter intake, body weight gain, feed conversion ratio and mortality during starter phase

Parameter	T1	T2	T3	T4	±SEM	Sign.
Total DM intake (g)	199.2^{a}	202.1^{b}	204.7^{c}	206.1^{c}	0.53	***
Daily DM intake (g)	28.5^{a}	28.9^{b}	29.2^{bc}	29.4^{c}	0.21	***
Initial weight (g)	150.3	150.3	149	148.7	0.96	NS
Final body weight (g)	337	314.7	308.2	323.4	2.17	NS
Weight gain (g)	186.7	165.7	159.6	173	2.02	NS
Daily weight gain (g)	26.7	23.7	22.8	24.7	0.76	NS
FCR	1.1	1.2	1.3	1.2	0.17	NS
Mortality (%)	0	0	0	0	0	NS

*** = P<0.001; Sign: significant; NS= Not-Significant; ±SEM: standard error of mean; T1: diet with 0% FCFL; T_2: diet containing 17% FCFL; T_3: diet containing 34% FCFL; T_4: diet containing 50% FCFL.
^Superscript with different alphabets in a row represent significant difference among treatment group

The mean daily and total DMI of chicken during the grower phase are presented in Table 6. The total and daily DMI during grower phase did not significantly (P>0.05) differ among the treatments. However, the mean daily DM intake of T_2 was less than those groups of chicks fed on the control ration. The result of mean daily and total DMI of broiler chicken during the finisher phase are presented in Table 7. The total and daily DMI during finisher phase were highly significant (P<0.001) different among the treatments.

The dry matter intake during the entire period of the experiment is presented in Table 8. The difference among total and daily dry matter intake were highly significant (P<0.001) among treatments. Dry matter intake by chicks indicated increasing trend from T1 to T3 with variation on T4 (Table 8) and similar trend occured in DMI on entire period. The current result disagreed with report of Asmamaw and Dinberu [26], who reported that an increased dried cafeteria left-over in the ration decreased feed intake of chickens. However, the result of this study is in agreement with that of Tamasgen [27], who reported that increasing level of dried food leftover up to 60% increased feed intake. It also agreed with the findings of Maeng *et al.* [30], who reported that increasing substitution levels of fermented leftover foods in the diet for laying hens resulted in increasing feed intake.

Table 6: Dry matter intake, body weight gain, feed conversion ratio and mortality during grower phase

Parameter	T1	T2	T3	T4	±SEM	Level of Significance
Total DM intake (g)	544.6	527.1	559.6	442.9	2.04	NS
Daily DM intake (g)	38.9	37.7	40	38.8	0.54	NS
Initial weight (g)	337	314.7	308.2	323.4	2.15	NS
Final body weight (g)	580.6	558.3	575	600	4.17	NS
Weight gain (g)	243.5	243.6	226.8	277.6	4.09	NS
Daily weight gain (g)	17.4	17.4	19.1	19.8	1.09	NS
FCR	2.3	2.2	2.1	2.0	0.37	NS
Mortality (%)	0	0	0	0	0	NS

Sign: significant; NS= Not Significant; SEM: standard error of mean; T1: diet with 0% FCFL; T_2: diet containing 17% FCFL; T_3: diet containing 34% FCFL; T_4: diet containing 50% FCFL.

Body Weight Gain

The effect of inclusion of FCFL in broilers ration on body weight gain is presented in Table 8. No significant difference was observed (P>0.05) in the initial, daily and final weight gain among treatment groups. T4 and T1 attained overall higher body weight gain followed by T2 and T3. This result is not in agreement with the findings of Asmamaw *et al,* [26], who reported significant variation in the average body weight and daily weight gain with diet contains increasing levels of dried cafeteria food leftover. In this study, the intake of birds increased when the FCFL increase across treatments with variation on T4 but the body weight gains of experimental birds was not increased considerably. This might be due to the deficiency of essential amino acids like lysine and methionine [29, 31]

Table 7: Dry matter intake, body weight gain, feed conversion ratio and mortality during finisher phase

Parameter	T1	T2	T3	T4	SEM	Level of Significance
Total DM intake (g)	2023^a	2051.2^b	2094.7^c	2077^c	1.62	***
Daily DM intake (g)	74.9^a	76^b	77.6^c	76.9^c	0.31	***
Initial weight (g)	580.6	558.3	575	600	4.17	NS
Final body weight (g)	1544.5	1422.3	1422.3	1544.5	6.34	NS
Weight gain (g)	963.9	863.9	847.3	944.5	6.18	NS
Daily weight gain (g)	35.7	32	31.4	35	1.19	NS
FCR	2.1	2.4	2.5	2.2	0.30	NS
Mortality (%)	0	0	0	0	0	NS

*** P<0.001; Sign: significant; NS= Not-Significant; SEM: standard error of mean; T1: diet with 0% FCFL; T_2: diet containing 17% FCFL; T_3: diet containing 34% FCFL; T_4: diet containing 50% FCFL.
^Superscript with different alphabets in a row represent significant difference among treatment group

Feed Conversion Ratio

The result showed that overall feed conversion ratio had no significant (P>0.05) difference among the treatment groups (Table 8). The result of this study accords with the recommended range of FAO [32], which stated that, the feed conversion ratios in poultry ranges between 2-4. The result also was in agreement with Tamasgen [27], who reported that, the feed conversion ratio did not differ significantly (p > 0.05) among treatments but tended to increase with inclusion level of dried cafeteria food leftover. However, the current finding disagrees with the results of Asmamaw *et al,* [26], who reported significant variation in feed conversion ratios among treatments. Amene and colleagues [28] also reported significant variation in feed conversion ratios.

Table 8: Dry matter intake, body weight gain, feed conversion ratio and mortality during the experimental period

Parameter	T1	T2	T3	T4	SEM	Level of Significance
Total DM intake(g)	2766.03^{a}	2780.43^{a}	2859.0^{b}	2826.07^{b}	2.40	***
Daily DM intake(g)	57.6^{a}	57.9^{a}	59.5^{b}	58.9^{b}	0.35	***
Initial weight (g)	150.3	149.0	148.7	150.3	0.96	NS
Final weight (g)	1544.5	1422.3	1422.3	1544.5	6.34	NS
Weight gain (g)	1394.1	1273.3	1273.6	1394.1	6.30	NS
Daily weight gain(g)	29.04	26.53	26.53	29.04	0.91	NS
FCR	2.0	2.2	2.3	2.1	0.24	NS
Mortality (%)	0	0	0	0	0	NS

*** P<0.001;NS= Not Significant; SEM: standard error of mean; T1: diet with 0% FCFL; T_2: diet containing 17% FCFL; T_3: diet containing 34% FCFL; T_4: diet containing 50% FCFL'

Carcass Traits

The result of carcass traits is presented in Table 9. Statistical analysis showed that there was no significant difference (P >0.05) in all parameters of carcass among the treatment groups. In agreement with the current finding Myer and colleagues [33] reported that food waste did not affect carcass parameters since nutrient requirement is met.

Table 9: Carcass yield characteristics of the treatment groups

Parameters	T1	T2	T3	T4	±SEM	Significance level
Slaughter weight	1266.7	1200	1283.3	1250	5.46	NS
Dressing percentage	77.5	74.9	74.4	78	1.34	NS
Eviscerated carcass (g)	921.7	837.9	889.5	902.7	4.76	NS
Breast meat (g)	246.1	224.5	229.4	234.7	2.85	NS
Drumstick (g)	124	115.6	123.6	132.3	2.72	NS
Thigh (g)	129.9	122.7	126.3	117	2.17	NS
Heart (g)	4.7	4.8	4.8	4.7	0.42	NS
Gizzard (g)	28.1	29.7	30.4	30.9	1.22	NS
Liver (g)	25	25.1	27.3	24.2	1.24	NS
Skin (g)	112.7	104.5	110	121.3	2.12	NS
Back (g)	147	123.5	141.1	142.3	2.30	NS
Wing (g)	106.7	97.9	103.3	102.9	1.78	NS
Neck (g)	55.3	49.1	55.8	52.2	1.59	NS

NS= Not-Significant; SEM: standard error of mean; T1: diet with 0% FCFL; T_2: diet containing 17% FCFL; T_3: diet containing 34% FCFL; T_4: diet containing 50% FCFL.

Partial Budget Analysis

The partial budget analysis of Sasso T_{44} dual -purpose chicks fed rations containing FCFL is presented in Table 10. The economic returns of broilers were determined based on the cost of feed consumed per treatment group and cost of chicks. The highest economic return was observed in T_4 followed by T_3, T_2 andT_1. This implies that, commercial feed ration can be replaced with FCFL up to 50% of the broilers' daily ration while maintaining good productivity, feed intake and carcass traits. The present result agrees with Amene and colleagues [28], who showed that, ration containing different levels of dried cafeteria food leftover inclusion in the concentrate mix was economically feasible than the control diet in feed cost/kg of live weight gain without affecting the dry matter intake and body weight gain.

The net return of broilers on T_4, T_3, T_2 and T_1 were 6774.3, 6616.7, 6495.7 and 6343.5 Birr, respectively. The marginal rate of return (MRR) indicated that each additional unit of 1 ETB per bird cost increment resulted additional profit for T_2, T_3, and T_4 of 100 ETB. The reasons for the increasing of net return in the groups from T_1 to T_4 could be due to the lower price and effectiveness of the feed FCFL for birds' production. The chicks' sale to feed cost ratio was estimated as additional parameter to realise the importance of FCFL when it included in commercial chicken rations. In this result, T4 was found to be good ration based on the performance of chicks and bio-economics of production. Similarly, Sehgal and his colleague [34] reported that leftover food could save production costs by substituting commercial feed by 25% with leftover foods.

Table 10: Partial Budget Analysis

Variable	Treatment groups			
	T1	T2	T3	T4
Cost of day old chicks (ETB/Treatment)	990	990	990	990
Starter feed consumed (kg)	9.89	9.94	9.98	9.96
Grower feed consumed (kg)	27.07	26.01	27.33	26.33
Finisher feed consumed (kg)	100.5	101.41	102.66	100.94
Cost of starter feed (ETB)	134.5	120.97	107.19	93.97
Cost of grower feed (ETB)	339.73	289.23	264.83	220.52
Cost of finisher feed (ETB)	1192.25	1053.14	919.32	771.18
Cost of processing of FCFL (ETB)	0	51	102	150
Total feed cost (ETB)	1666.5	1514.3	1393.3	1235.7
Total variable cost(ETB)	2656.5	2504.3	2383.3	2225.7
Number of broilers reaching market	45	45	45	45
Selling price/bird (ETB)	200	200	200	200
Total return	9000	9000	9000	9000
Net return	6343.5	6495.7	6616.7	6774.3
∆NR	-----	152.2	273.2	430.8
∆TVC	-----	-152.2	-273.2	-430.8
MRR (%)	------	-100	-100	-100
Chicks sale/feed cost	5.4	5.9	6.5	7.3

ETB = Ethiopian Birr (with current currency of 1USD= 27.21ETB) , ∆TVC = change in total variable cost, ∆NR = change in net return; MRR = marginal rate of return; T1 = 0% of FCFL; T2 = 17% FCFL; T3 = 34% of FCFL; T4 = 50% of FCFL.

Mortality

There was no mortality of chicks during the experimental period.

Conclusion and Applications

1. Inclusion of FCFL in birds ration up to 50% has indicated improvement (progress) in feed intake and growth performance of the birds. Hence, FCFL is an important source of feed for birds in reducing feed cost but maximizing the net return. This could also have great role in minimizing competition for cereal grains between poultry and human being.
2. Use of FCFL can give an option to minimize environmental pollution and human health risk from wasted food leftover.
3. However, further study is advocated to incorporate FCFL in commercial rations for poultry and other animals.

Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this paper.

Authors' Contributions

All authors read and approved the final version of the manuscript. LA, AB, AB, GB, BG, NK, HG and MR conceived the study. LA, AB, AB, GB and HG generated the idea, developed scientific proposal, performed field work, analyzed the data and prepared the paper. BG, NK and MR participated on proposal development, scientific research and paper writing.

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