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Research article

Strategies of whey feeding and its effect on growth performance, meat composition and hematological changes in Sonali Chicken

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Abstract

The study aimed to evaluate the effect of whey supplemented in mixed feed diet on growth performance, carcass quality and meat characteristics as well as hematological parameters of growing Sonali chicken. Three hundred sixty, day-old Sonali chicks were procured from government poultry development and breeding farm, Sylhet. They were randomly divided into four dietary treatments (T_0 - control group; T_1 - whey with drinking water; T_2 -whey fermented feed and T_3 - commercial feed) with three replications in each group (n=30X3) and reared for 8 weeks. Feed intake was recorded on regular basis and growth performance (g) was observed fortnightly. The result showed that oral feeding of whey reduced feed intake but increased dressing percentage (63.4%) and weight gain (424.73±2.23) than that of other groups with significance ($p<0.05$), lead to better FCR in T_1 (2.69±0.03) group followed by T_0 (2.79±0.03), T_2 (2.94±0.03), T_3 (2.97±0.03) respectively. Similarly, CP, CF, TA, EE and NFE content (%) of different meat cuts were varied significantly ($p=0.001$) with highest DM% in T_2 (28.70±0.75) thigh meat, reflect better total yield of CP% in meat than other groups while hematological parameters showed no variation containing good count of RBC (2.97±0.04) and WBC (2.22±0.04) within standard range in T_1 group which implied good immunity and health condition in the chickens. In general, addition of whey in water showed better FCR to quality meat yield and it can be concluded that incorporation of whey through oral administration seems better than whey fermented feed to save time and raise revenue.

Keywords: Fermentation, Performances, Sonali chicken, Strategies, Whey

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INTRODUCTION

Poultry is the most important and advanced segment of the livestock sector in Bangladesh, making it interesting for both domestic entrepreneurs and foreign investors. Over the years, the demand for poultry products in Bangladesh has grown significantly; per capita consumption per year increased to 8.5 kg poultry meat and 5.1 kg (104 pieces) eggs in 2019 (UKAID, 2019). Sonali chicken, the crossbred of Rhode Island Red (RIR) male and Fayoumi female was developed in 1986, has similar phenotypic appearance and taste to that of local non-descript chickens. Between 1996 and 2000, Bangladesh's Department of Livestock Services (DLS) introduced Sonali crossbred chicken in the northern areas of the country through various projects, creating jobs for millions of rural women (FAO, 2015). Sonali rearing is rapidly becoming popular because of its better production records, higher disease resistance, lowest mortality and highest profit rate per hen (Rahman et al., 2007). Moreover, the poultry producers of Barishal district have recently noticed a trend of Sonali chicken farming (Howlader et al., 2022). Feed additives or growth promoters have been used to improve growth rate, feed efficiency, and product quality and to lessen the production cost in poultry (Chauhan et al., 2020). Various antibiotics, anthelmintic, anticoccidial and hepatic-protectants are used for increasing production. They not only increase the cost of production but have adverse effects on long term usage. Due to the prohibition of most of the antimicrobial feed additives in animal feed and their residual effects in animals (Singh et al., 2017) organic mineral mixtures, probiotics, enzymes, and emulsifiers are becoming more popular. The use of antibiotics as growth promoters in the poultry industry is of great concern to consumers because of emerging antibiotic-resistant of microbiota (Kermanshahi et al., 2017). Hence several studies tried to look for alternative of antibiotics and suggested many substitutes for the poultry industry (Abd El-Hack and Alagawany, 2015). One of these alternatives is whey powder, which can be used as a probiotic and has non-residual and non-resistant properties (Zarei et al., 2018). The use of whey in poultry diets is limited by its high lactose and mineral contents (Tsiouris et al., 2020) but it has been reported to contain unidentified growth factor(s) when added to the diet of chickens (Kanza et al., 2017). Whey also contain antioxidative ability due to peptides derived from β-lactoglobulin and α-lactalbumin (Corrochano et al.,2018) and thus inclusion of it enhance growth and antioxidant status of broiler (Afkhami et al., 2020). The global growth rate of whey generation is around 2% per annum (Smithers, 2008). A portion of cheese whey is applied to food and utilized as animal feed. On the other hand, because of its high organic content and mass production, whey poses serious environmental and health risks (Tsiouris et al., 2020). When whey is dumped on land, the physicochemical properties of the soil are altered lowering crop yields and poses serious environmental contamination concerns along with a major risk to aquatic life and human health (Yadav et al., 2015). On this context, if this high amount of whey can be used in improvement of nutritional status poultry feed and enhancing production then it will be also beneficial for decreasing environmental pollution also. Though, many studies have been done with whey using it in powder and concentrate form to evaluate the capability of increasing productivity but incorporating it through fermentation into poultry feed isn't studied well till now. Hence this study was carried out to find out better strategy for supplementing whey and its effect on growth performance along with nutritive content of meat of Sonali chicken.

MATERIALS AND METHODS

The present experiment was conducted to assess the effect of whey fermented feed on growth performance of Sonali chicken, to evaluate chemical composition of meat and cost benefit ratio. This study protocol was reviewed and

approved by the Animal Experimentation Ethics Committee, Sylhet Agricultural University, Bangladesh (License no. #AUP20220043). The details of the experimental procedures and techniques adopted during the period of present investigation are given below.

Study Area and population

The experiment was conducted at the poultry shed which was situated at Sylhet Agricultural University, Sylhet. It is located on the six kilometers east of the Sylhet City Corporation. The chemical analysis of meat and blood samples was carried out in the Animal Nutrition Analytical Laboratory and Physiology laboratory. A total number of 360 Sonali day old chicks were bought at 20 Tk/ bird ($1US= 109.67 Tk) from Sylhet poultry development and breeding farm. BCRDV and IBD vaccines were given to the flock before bringing them in the shade.

Formulation of whey added ration

Sonali chickens were supplied hand mixed feed (NRC, 1994) and commercial feed (United Feed Ltd. company) which were purchased from the local feed dealer. Whey which was produced while making sweets, was collected from local sweet shops in a liquid form for the study and it was then incorporated with hand mixed feed and kept in incubation for 48 hours for fermentation. The Proximate Composition for hand mixed feed and commercial feed is depicted in Table 2.

Experimental layout of the birds

After collecting the day-old chicks, they were divided into four dietary groups each having 90 birds. Among the groups, there were three replications in each consist of 30 birds. The treatment groups were T_0, T_1, T_2 and T_3 which has been given handmade mixed feed without whey (T_0), whey (5%) through drinking water and mixed feed (T_1), whey fermented mixed feed (T_2) and commercial grower feed (T_3) respectively. At first week, 10g of feed was given for each bird and it was continued up to 50g of feed per bird per day in each group and addition of 5g of feed supply in every week till 8th week. Fresh and dried rice husk was collected from rice mill and used as litter (bedding material) at a depth 2-3 inch. After 5 weeks, old litter was totally removed and new litter was provided as same depth to avoid any coccidial infection. The litter was turned over one time per day from four weeks to end day of experimental period. Besides, lime powder was added to the litter @3kg per 100 Kg. The birds were exposed to similar care and management in all treatment groups throughout the experimental period. Before entry of day-old chick, Pre-heating was done in the brooding space and temperature was adjusted at 33±2 ºC. After entry in experimental shed, chicks were provided vitamin C and glucose latter one hour feed was provided. At first day temperature was maintained at 33± 2ºC then gradually decrease 1ºC per day. For brooding electric brooder was used to provide heat and warm up the chick at experimental house. The brooder was hanged just above the bird level at the center of chick guard. Temperature and humidity were checked by using clinical thermometer and hygrometer. The birds were exposed to 23 hours of lighting and 1hour dark period throughout the experimental period.

Data collection

Initial body weight was measured with the help of weight machine after collecting the birds from Sylhet Government Poultry and Duck farm. Body weight of the chicks, feed intake information was taken on regular basis. Residual feed from each unit was collected and weighed to measure exact feed intake (FI). Obtained data were used to calculate the feed conversion ratio (FCR). Birds were kept in regular monitoring to avoid any health issues. After the experimental period of 8th week, final weight was taken and 8 birds in each group was taken for post slaughter data collection. For hematological parameters, blood samples (about 4.0

ml) were collected aseptically from their wing vein, using sterilized syringes and needles (24-gauge needle) then was transferred to the vials containing anticoagulant ethylene diamine tetraacetate (EDTA) and used for estimation of hemoglobin (Hb), packed cell volume (PCV), red blood cells (RBC) and white blood cells (WBC) using Hematology Analyzer, PE-7010vet (analyzed in VWB-CBC+DIFF mode). According this, birds were slaughtered and kept for some time to bleed properly. For calculating the carcass yield characteristics, dressed birds were divided into many pieces, including thigh, wings, breast, and drumsticks. After dressing properly, 50 gm sample of breast, drumstick, thigh and wing fresh muscle were taken and then minced, dried grounded with the help of mortar and pastel to analyze the nutritive content (DM%, CP%, ASH%, EE%, CF% and NFE%) of it following the procedure of AOAC (1999) method on dry matter basis.

Proximate analysis of whey fermented feed

Chemical analysis of whey fermented feed was done to determine the nutritive following the methods of AOAC (1999) on dry matter basis.

Table 1 Chemical composition of the mixed feed and whey fermented feed

Chemical composition (%)	Mixed Feed	Whey fermented mixed feed
CP	17	17.25
CF	15.67	14.45
EE	8.78	9.78
TA	9.9	10.78
NFE	48.65	47.74

Measuring of weight gain, dressing percentage and feed efficiency

Total gain in weight (g)

This was computed as a group by subtracting the initial weight from the final weight.

Total gain in weight = final weight – initial weight

Dressing percentage

The dressing percentage of sonali chicken was calculated as follows:

Dressing (%) = (Dressed Weight ÷ Live Body Weight) x 100 (Jeannine, 2011)

Total feed consumption (kg)

The amount of feed consumed by the birds from the start until the end of the experiment (56 days). This was computed by adding the total feeds offered after the total left- over have been subtracted.

Total feed consumption = total feed offered – total left-over

Calculation of cost and profit

Net profit was calculated by subtracting all the cost (chick cost, feed cost and miscellaneous cost included vaccine, medicine, litter, labor, electricity, whey and transport cost) from the total selling price of the chickens.

Statistical data analysis

Data were recorded in Microsoft Excel and analyzed by using SAS 9.3.1 software. All values were expressed as Least Square Mean± SE and significance was determined when ($P<0.05$). Mean was compared among the treatment groups by using Duncan Multiple Range Test (DMRT).

RESULTS

The results revealed the effect of whey fermented feed on the growth performance, carcass characteristics, and hematological parameters of Sonali chicken and way out of feeding nutritious economic ration that can be given to poultry.

Growth parameter of Sonali chicken

The table 2 represents the body weight change of Sonali chicken fed with and without whey as well as whey fermented feed up to end of the experiment. Initial body weight (g) of Sonali chicks fed on different dietary treatments was similar 32.42g with no statistical significance. But Final live weight gain was statistically significant ($p<0.05$) among the different treatment group. The highest body weight gain 457.13g was attained in T_1 group which was supplemented with whey feeding through drinking water which was followed by T_0, T_2 and T_3 group respectively. The mean value of the body weight of T_0, T_1 treatment groups were 441.76g and 457.13g projecting the significant difference between and also among other groups but mean of T_2 (413.03g), T_3 (412.43g) group showed no significant difference from each other (Table 3). The highest ($p<0.001$) body weight gain was found in whey fed with drinking water group (T_1) followed by control group (T_0), commercial feed fed group (T_3) and whey fermented feed group respectively.

Table 2 Ration for Sonali chickens up to 8 weeks.

Feed ingredients		Amount			
		T_0	T_1	T_2	T_3
1. Maize (%)		50	50	50	Commercial Grower Feed
2. Wheat Bran (%)		10	10	10	
3. Auto Rice Polish (%)		10	10	10	
4. Ghee Residue (%)		27.5	27.5	27.5	
5. DCP (%)		1.3	1.3	1.3	
6. Mould (%)		0.1	0.1	0.1	
7. NaCl (%)		1	1	1	
8. Vitamin Mineral Premix (%)		0.1	0.1	0.1	
9. Raw whey (%)		-	**5	*5	
Nutritive Content	ME (Kcal/kg)	2690	2690	2690	2850
	CP (%)	17	17	17.25	16.75
	Ca (%)	0.9	0.9	0.9	2

*5% amount whey was mixed and allowed for incubation for fermenting with mixed feed for 48 hours after formulating the feed.
**5% of whey was added with water in T_1 group.

Feed intake and FCR of the Sonali growing chicken fed without whey and whey fermented feed

Table 4 shows that there was no statistical significance ($p=0.78$) in daily and total feed intake of the experimental birds although total body weight gain showed a high significance ($p<0.001$). Total feed intake was found highest in T_0 group which was 1151.09g/b and lowest was in T_3 group while the FCR was found best in T_1 group which is 2.69 among other groups which took moderate feed intake (1140 g/b). The highest value of FCR (2.97) was shown by treatment group T_3 which was given commercial grower feed rather than other groups. there were slight differences among the treatment group in respect of live wight, dressing percentage and hot carcass weight. Relatively better dressing percentage was

observed in T_1 (63.64%) than other that of treatments. The highest dressing percentage in T_1 was the reflection of higher live weight of bird.

Table 3 Body weight change of Sonali growing chicken fed without whey and whey fermented feed

Parameter	Treatments				SEM	P-value
	T_0	T_1	T_2	T_3		
DOCW (g)	32.42±0.01	32.42±0.01	32.41±0.01	32.40±0.01	0.004	0.282
TWG (g)	441.76^{b}±2.23	457.13^{a}±2.23	413.03^{c}±2.34	412.43^{c}±2.34	11.054	0.0001
TWC (g)	409.36^{b}±2.23	424.73^{a}±2.23	380.63^{c}±2.34	380.03^{c}±2.34	11.054	0.0001
WG (g/b/d)	8.84^{b}±0.20	10.56^{a}±0.20	8.70^{bc}±0.21	9.43^{b}±0.21	0.423	0.0001

^{abc} mean within row with different superscript letters are significantly different.
DOC= Day Old Chick, TWC= Total Weight Change, TWG= Total Weight Gain, WG= Weight Gain, g/b/d= Gram per Bird per Day, T_0=Mixed Feed, T_1= Mixed Feed and Whey with water, T_2= Mixed Feed Fermented with Whey, T_3= Commercial grower feed, SEM=Standard Error Mean.

Chemical composition of meat

The tables (4, 5, 6, 7) exhibit the nutrient composition of meat of Sonali chicken fed on whey and without whey. The dry matter, crude protein, ash, crude fiber, ether extract and nitrogen free extract showed highly significant relation ($p< 0.001$) in all samples of breast, drumstick, thigh and wings meat. In breast meat (Table 5), the highest water holding capacity was found in control group meat. Highest DM content and mineral assimilation was found in whey with drinking water T_1 group and whey fermented ($p<0.001$) group (T_2) respectively. Deposition of fat was observed better in whey fed in drinking water group. Breast meat of T_1 group possessed highest CF content followed by T_3, T_2 and T_0 group. On the other hand, soluble carbohydrate (NFE) was found in highest limit in T_3 group followed by T_0, T_2 and T_1 group. In table 6, whey fermented mixed feed group (T_2) showed highest percentage of DM, CF, mineral and N assimilation in drumstick meat which was significantly ($p<0.001$) different from other groups. On the contrast, soluble carbohydrate (NFE) and deposition of fat was found in lowest limit in T_2 group. Meanwhile, water holding capacity in drumstick meat was highest in control group similarly as thigh meat and wing meat composition showed at table 7 and table 8 respectively. Whey supplemented treatment groups (T_1, T_2) showed highest DM, mineral and N assimilation content in thigh and wing meat and varied significantly ($p<0.001$) from other groups. Deposition of fat was lowest in T_3 group in these parts of meat. CF content showed no significant differences among the groups in thigh meat.

Table 4 Feed intake and FCR of Sonali chicken

Parameter	Treatments				SEM	P-value
	T_0	T_1	T_2	T_3		
TWC (g/b)	409.36^{b}±2.23	424.73^{a}±2.23	380.63^{c}±2.34	380.03^{c}±2.34	11.054	0.0001
TFI (g/b)	1151.09±19.99	1140.30±19.99	1122.01±20.96	1131.84±20.96	6.18	0.786
DFI (g/b)	17.98±0.31	17.81±0.31	17.67±0.32	17.54±0.32	0.094	0.783
WWG(g/b)	36.33±1.42	37.84±1.42	37.08±1.49	35.58±1.49	0.486	0.723
FCR	2.79^{a}±0.03	2.69^{ab}±0.03	2.94^{bc}±0.03	2.97^{d}±0.03	0.065	0.0001

^{abcd} mean within row with different superscript letters are significantly different.
TWG= Total Weight Gain, TFI= Total Feed Intake, DFI= Daily Feed Intake, WWG= Weekly Weight Gain, FCR= Feed Conversion Ratio, g/b=Gram per Bird, T_0=Mixed Feed, T_1= Mixed Feed and Whey with water, T_2= Mixed Feed Fermented with Whey, T_3= Commercial grower feed, SEM=Standard Error Mean.

Table 5 Chemical composition of Breast meat among different treatment groups

Parameter	Treatments				SEM	P-value
	T_0	T_1	T_2	T_3		
DM (%)	23.15^{cd}±0.75	27.69^{ab}±0.75	24.71^{cd}±0.75	27.68^{ab}±0.75	1.129	0.0001
TA (%)	6.48^{b} ±0.29	5.54^{c}±0.29	8.15^{a} ±.29	6.28^{bc}±0.29	0.550	0.0001
CP (%)	63.68^{a}± 2.61	58.86^{b}± 2.61	62.52^{a}± 2.61	57.86^{b}± 2.61	1.403	0.0001
EE (%)	8.40^{c}± 0.51	10.60^{a}± 0.51	8.22^{c}± 0.51	9.00^{b}± 0.51	0.541	0.0001
CF (%)	9.47^{d}± 0.69	14.56^{a}± 0.69	10.12^{bc}± 0.69	10.64^{b}± 0.69	1.147	0.006
NFE (%)	11.95^{b}± 2.41	10.42^{c}± 2.41	10.97^{c}± 2.41	16.20^{a}± 2.41	1.310	0.0001

^{abcd} mean within row with different superscript letters are significantly different.
DM= Dry Matter, TA= Total Ash, CP= Crude Protein, EE= Ether Extract, CF= Crude Fiber, NFE= Nitrogen Free Extract, T_0=Mixed Feed, T_1= Mixed Feed and Whey with water, T_2= Mixed Feed Fermented with Whey, T_3= Commercial grower feed, SEM=Standard Error Mean.

Table 6 Chemical composition of Drumstick meat among different treatment groups

Parameter	Treatments				SEM	P-value
	T_0	T_1	T_2	T_3		
DM (%)	22.47^{d}±0.75	23.98^{c}±0.75	26.93^{a}±0.75	24.33^{b}±0.75	0.926	0.0001
TA (%)	5.85^{bc}±0.29	5.74^{cd}±0.29	6.35^{a}±0.29	5.53^{d}±0.29	0.173	0.0001
CP (%)	50.09^{b}±2.61	50.90^{b}±2.61	52.90^{a}±2.61	50.70^{b}±2.61	0.609	0.0001
EE (%)	13.90^{a}±0.51	13.49^{ab}±0.51	12.56^{c}±0.51	13.95^{a}±0.51	0.321	0.0001
CF (%)	11.30^{bc}±0.69	11.87^{ab}±0.69	11.92^{a}±0.69	10.83^{d}±0.69	0.258	0.006
NFE (%)	18.85^{a}±2.41	17.98^{b}±2.41	16.26^{c}±2.41	18.97^{a}±2.41	0.639	0.0001

^{abcd} mean within row with different superscript letters are significantly different.
DM= Dry Matter, TA= Total Ash, CP= Crude Protein, EE= Ether Extract, CF= Crude Fiber, NFE= Nitrogen Free Extract, T_0=Mixed Feed, T_1= Mixed Feed and Whey with water, T_2= Mixed Feed Fermented with Whey, T_3= Commercial grower feed, SEM=Standard Error Mean.

Table 7 Chemical composition of Thigh meat among different treatment groups

Parameter	Treatments				SEM	P-value
	T_0	T_1	T_2	T_3		
DM (%)	25.46^{c}±0.75	26.52^{b}±0.75	28.70^{a}±0.75	26.27^{b}±0.75	0.692	0.0001
TA (%)	5.17^{d}±0.29	7.25^{a}±0.29	6.49^{b}±0.29	6.19^{bc}±0.29	0.430	0.0001
CP (%)	38.88^{b}± 2.61	42.14^{a}± 2.61	38.36^{bc}± 2.61	38.18^{c}± 2.61	0.928	0.0001
EE (%)	17.06^{bc}± 0.51	17.45^{b}± 0.51	19.31^{a}± 0.51	15.63^{c}± 0.51	0.757	0.0001
CF (%)	11.02± 0.69	11.02± 0.69	11.02± 0.69	11.01± 0.69	0.005	0.066
NFE (%)	27.86^{a}± 2.41	22.14^{bc}± 2.41	24.80^{ab}± 2.41	28.97^{a}± 2.41	1.543	0.0001

^{abcd} mean within row with different superscript letters are significantly different.
DM= Dry Matter, TA= Total Ash, CP= Crude Protein, EE= Ether Extract, CF= Crude Fiber, NFE= Nitrogen Free Extract, T_0=Mixed Feed, T_1= Mixed Feed and Whey with water, T_2= Mixed Feed Fermented with Whey, T_3= Commercial grower feed, SEM=Standard Error Mean.

Table 8 Chemical composition of Wings meat among different treatment groups

Parameter	Treatments wings				SEM	P-value
	T_0	T_1	T_2	T_3		
DM (%)	23.30^{c}±0.75	24.32^{bc}±0.75	24.41^{b}±0.75	25.59^{a}±0.75	0.468	0.0001
TA (%)	5.61^{b} ±0.29	5.49^{bc}±0.29	6.60^{a}±0.29	5.73^{b}±0.29	0.252	0.0001
CP (%)	53.45^{a}± 2.61	41.21^{c}± 2.61	43.60^{b}± 2.61	41.48^{c}± 2.61	2.888	0.0001
EE (%)	13.58^{b}± 0.51	16.99^{a}± 0.51	13.06^{bc}± 0.51	12.98^{d}± 0.51	0.955	0.0001
CF (%)	11.66^{c}± 0.69	12.15^{b}± 0.69	12.48^{a}± 0.69	10.06^{d}± 0.69	0.536	0.006
NFE (%)	15.68^{d}± 2.41	24.15^{bc}± 2.41	24.24^{b}± 2.41	29.73^{a}± 2.41	2.900	0.0001

^{abcd} mean within row with different superscript letters are significantly different.
DM= Dry Matter, TA= Total Ash, CP= Crude Protein, EE= Ether Extract, CF= Crude Fiber, NFE= Nitrogen Free Extract, T_0=Mixed Feed, T_1= Mixed Feed and Whey with water, T_2= Mixed Feed Fermented with Whey, T_3= Commercial grower feed, SEM=Standard Error Mean.

Hematological analysis of the Sonali chicken fed whey and whey fermented feed

The results of the hematological analysis of the experimental chickens fed with or without whey showed no significance differences among the groups (table 9). Red blood cell count was found maximum (2.97 cells 10^6/µl) in whey fed with drinking water group (T_1) among other treatment groups followed by T_2 (2.85 cells10^6/µl), T_3 (2.59 cells10^6/µl) and T_0 (2.55 cells10^6/µl). T_1 group showed highest percentage of packed cell volume (28.5%) in relation to other groups. Similarly, White blood cell count increased slightly in T_1 (2.22 cells 10^3 /µl) group and found lowest in control group. Though Differential leukocyte count (Neutrophil, Lymphocyte, Eosinophil, Monocyte, Basophil) was within reference value but varied from one group to another. In T_2 group, Neutrophil percentage was more (28.59%) than other groups but lymphocyte percentage was minimum (63.8%) in this group. Hemoglobin production was found better in group fed with whey fermented feed (8.38 g/dl) and whey supplemented with drinking water (8.33 g/dl) respectively than other groups in which whey was not provided.

Table 9 Effect of whey fermented feed on hematological parameters on Sonali chicken

Parameters	Treatments				Reference value
	T_0	T_1	T_2	T_3	
RBC (cells10^6/µl)	2.55±0.04	2.97±0.04	2.85±0.04	2.59±0.04	2.5-3.5
PCV %	26.41±0.32	28.5±0.32	26.9±0.32	28.10±0.32	22-35
WBC (cells 10^3 /µl)	2.17± 0.04	2.22±0.04	2.18±0.04	2.20±0.04	1.2-3
Neutrophil %	27.8±1.15	28.59±1.15	28.48±1.15	28.10±1.15	15-40
Lymphocyte %	64.9±1.90	63.8±1.90	64.4±1.90	64.8±1.90	45-70
Eosinophil %	2.51±0.24	2.31±0.24	2.46±0.24	2.44±0.24	1.5-6
Monocyte %	1.55±0.17	1.58±0.23	1.65±0.24	1.66±0.24	1-5
Basophil %	0.79±0.05	0.93 ±0.05	0.88±0.05	0.82±0.05	Rare
Hb (g/dl)	8.12±0.10	8.33±0.10	8.38±0.10	8.19±0.10	7-13

RBC= Red Blood cell, WBC= White Blood Cell, PCV= Packed Cell Volume, Hb= Hemoglobin, T_0=Mixed Feed, T_1= Mixed Feed and Whey with water, T_2= Mixed Feed Fermented with Whey, T_3= Commercial grower feed, SEM=Standard Error Mean.

Economic analysis of Sonali chicken fed whey and whey fermented feed

Production cost of Sonali chicks in this study are presented in figure 1. Estimated cost were chick cost, feed cost and miscellaneous cost included vaccine, medicine, litter, labor, electricity, whey and transport cost. Cost and profit were calculated as cost per kg and profit per Kg.

Feed cost was found higher in case of commercial feed whereas control group had the lowest feed cost. Total cost per Kg. production was lowest in T_1 group where whey was supplemented with water which is 153.52 Tk. followed by 168.58 Tk, 172.35 Tk. and 185.84 Tk. in T_2, T_0 and T_3 group respectively. Net profit was found higher in groups T_1 and T_2 where whey was used as the production was better.

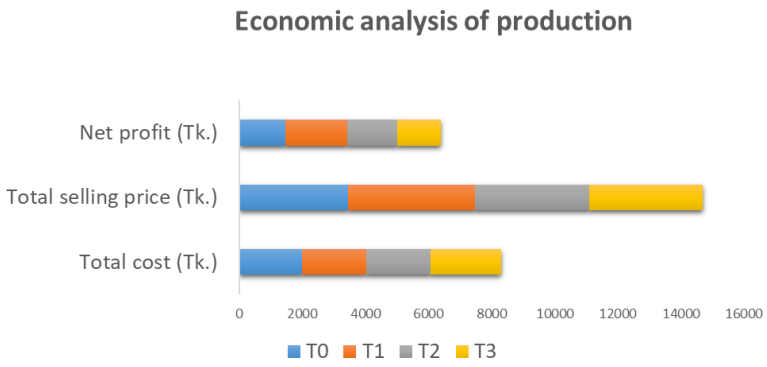

Figure 1 Economic analysis of production

DISCUSSION

Growth performance of Sonali chicken

Supplementation of whey had a great impact on body weight gain with statistical significance ($p<0.05$) specially in T_1 group where chicken was fed whey through water showed higher body weight gain. Increased body weight in whey fed with drinking water group, might be due to availability, stimulation and easy absorption of nutrients by the gut villi. Similarly, modulation of caecal microbiota communities improved growth of chickens after incorporating whey with feed (Pineda-Quiroga et. al.,2018) and also body weight gain was greater for chickens offered whey protein (Kermanshahi and Rostami, 2006; Malik et al., 2015) which resulted in greater intestinal villus, leading to a more efficient nutrient utilization and subsequently enhanced performance of chicks (Long et al.,2018) but a contradictory finding showed that addition of 5% whey decreased significantly the final body weight (Tsiouris et al.,2020).

Feed intake and Feed conversion ratio

Total Feed intake had no significant ($p>0.05$) relation between the treatments. Highest intake of feed was found in control group (1151.09g) and lowest intake was in T_2 group. From the study, it is assumed that whey had an adverse effect on feed intake which is caused by the lactose and mineral contents of whey, the presence of it in the drinking water depressed the ratio of total water intake to food DM intake, reinforcing the adversative effect (Shariatmadari and Forbes, 2005). Feed conversion ratio is better in the groups where whey has been supplemented with water (2.69) compared to other groups and showed a significant relation ($p<0.05$). This result is because of low feed intake in relation to

high weight gain. According to Hilmi et al. (2020), addition of fermented whey with water caused minimal FCR of laying hens aged 18 to 26 weeks as result of nutrients content of whey.

There were slight differences in dressing percentage among the treatment groups. The highest dressing percentage (63.64%) was found in T_1 treatment group which is possibly due to whey proteins that support muscle building with its essential amino acid content (Majewska et al., 2009; Ibrahim et al.,2015) and increased the capacity of uptaking nutrients by villi. This theory was also proved by Bahari et al. (2015) who said that supplementation of 0.4% dried whey powder in broiler diets increases the relative weights of carcass, breasts, drum sticks, and wings. Although, Al-Asadi et al. (2008) found no significant effects on carcass traits in broilers, fed diets enriched with 0.25 and 0.50% whey powder.

Meat composition analysis of Sonali Chicken

Meat composition (DM%, TA%, CP%, EE%, CF%, NFE%) presented in results were found different at different treatment groups but showed a significant relation ($p<0.05$). In all part, DM% and CP % was better in T_1 and T_2 treatment group, which implied more nutritive content found in whey fed chicken muscles. It might be because of high biological value of whey containing amino acids, such as cysteine and methionine (Fox and MacSweeney, 2008) which caused maximum dry matter content and CP content in whey supplemented feed (Huwaida et al., 2013) as well as drastic capacity increased of villi. Ash content in different parts of chicken were found maximum (Breast- 8.15%, Drumstick- 6.35%, Thigh- 7.25% and Wings- 6.60%) in groups where whey was supplemented through water (T_1) or with mixed feed (T_2) rather than groups without whey supplementation. Mineral contents in whey may have increased the availability of these minerals in the intestinal lumen to blood stream that might increase metabolic rate. This had helped chickens to live with maximum physiological fitness and excel in production to fetch more income. The result is supported by other studies of Yadav et al. (2015); Ziegler and Fomon (2004) in their study also suggested that lactose in whey promotes absorption of different mineral ions.

Hematological parameter of Sonali Chicken

The result of the hematological analysis of the experimental Sonali chicken in this study revealed no significant differences among the group. The result was near to normal blood reference values of *Gallus Gallus domesticus* (Jain, 1993) after supplementation of whey protein (table 8). Though there was no significant ($p>0.05$) relation among the group, Red blood cell (RBC) count was found maximum (2.97 cells 10^6/µl) and packed cell volume (28.5%) in whey fed with drinking water group (T_1) among other treatment groups. Hemoglobin (Hb) production was found better in group fed with whey fermented feed (8.38 g/dl) and whey supplemented with drinking water (8.33 g/dl) respectively than other groups in which whey was not provided. Acceleration in RBC, PCV and Hb in whey supplemented groups might have been due to increase absorption of iron and copper minerals required for the synthesis of heme pigment which is usually present in whey. Kaushal et al. (2015) in their experiment also found improved Total Erythrocyte, Hb proliferation and maturation of blood cells. White blood cell count increased slightly in T_1 (2.22 cells 10^3 /µl) group and found lowest in control group (T_0). Immunoglobulin and lysozyme in whey (Paul et al., 2002), might have suppressed the pathogens in gut and provided immunity enhancing benefits thus overall blood cells count was found within the normal range. The similar result was obtained from Singh et al. (2013) who reported that Total Leukocyte count (TLC) values was slightly higher in whey treated group that receive whey in drinking water compared to control group in broiler with no significance.

Economic efficiency of Sonali chicken fermented whey feed

Total cost per Kg. production was lowest in T_1 (Tk. 153.2) group where whey was supplemented with water followed by T_2 (Tk. 168.52), T_0 (Tk. 172.5) and T_3 (185.84 Tk.) group respectively. Control group had the lowest feed cost but high absorption capacity of nutritive component by intestinal villi in whey fed with drinking water (T_1) group accelerate the production of meat so profit was estimated more in this group (T_1). Net profit was found higher in groups T_1 and T_2 chronicled where whey was used. Highest profit was gained in T_1 (Tk. 146.47 /Kg) group followed by in T_2 (Tk. 131.48 /kg), T_0 (Tk. 129.32/kg) and T_3 (Tk. 114.15/kg) group consecutively.

CONCLUSIONS

Considering the above discussions, it is concluded that whey supplementation either in drinking water or feed fermentation is convenient in improving better feed utilization to growth performance as well as carcass quality to meat contents as probiotic and value-added product for Sonali chicken feeding.

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AUTHOR CONTRIBUTIONS

Mahfuza Ferdous: Conceptualization, Data curation, Interpretation, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing
Md. Jasim Uddin: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing
Jannatul Mawa Momu: Writing – review & editing
Jakia Sultana Koly: Writing – review & editing
Mustasim Famous: Writing – original draft, Visualization, Writing – review & editing.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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