Asian Journal of Research in Animal and Veterinary Sciences

Volume 7, Issue 2, Page 122-133, 2024; Article no.AJRAVS.115477

Effect of Adding Different Levels of Undecorticated Rosehip (*Rosa canina* L.) Fruit in the Diets on Productive Performance of Broiler Chickens

S. B. Monesa [a] and O.I.A. Oluremi [a*]

[a] *Department of Animal Science, Faculty of Agriculture, The National University of Lesotho, P.O. Box 180, Roma, Lesotho.*

Authors' contributions

This work was carried out in collaboration between both authors. Author OIAO designed and supervised the study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRAVS/2024/v7i2292

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/115477

Original Research Article

Received: 11/02/2024
Accepted: 15/04/2024
Published: 24/04/2024

ABSTRACT

This study was conducted to investigate the efficacy of rosehip (*Rosa canina* L.) fruit as a natural dietary supplement on the growth response of broiler chickens. Two hundred and four unsexed day-old Cobb 500 broiler chickens were used in a 42-day trial to investigate the efficacy of undecorticated rosehip (*Rosa canina* L.) fruit as a natural dietary supplement on growth of chickens. Birds were grouped into four of equal number and similar live weight with three sub-groups each. One group each was randomly assigned to one dietary treatment. Experimental diets consisted of a uniform commercial basal diet in which air dried and milled rosehip fruit was added as a supplement at the rate of 0, 100, 200 and 300 g/100 kg to give diets T1, T2, T3 and T4, respectively. Data collected were on growth performance, carcass yield and GIT morphometry and were subjected to the one-way analysis of variance. Rosehip fruit supplement significantly ($P<0.05$) affected feed consumption, protein intake, mortality, dressed weight, percent dressed weight of wing and

**Corresponding author: E-mail: oia.oluremi@nul.ls, oiaoluremi@yahoo.com;*

drumstick of chickens. Percent live weight of heart, kidney, pancreas, proventriculus and spleen varied significantly (P<0.05). Rosehip fruit supplement reduced (P<0.05) percent GIT length of large intestine and caeca at higher supplement value. Undecorticated rosehip fruit is high in crude protein, crude fibre and low in energy. Undecorticated rosehip fruit at 100 to 300 g/100 kg dietary supplementation did not enhance the growth of broiler chickens but, gave high dressing percentages of 80.03% to 80.83% comparable to 80.68% in the control group, and decreased percentage large and small intestines of the tract significantly. Undecorticated rosehip fruit can be fed as dietary supplement at the rate of 100 to 300 g/100 kg to produce broilers of high dressing percentage.

Keywords: Undecorticated rosehip fruit; broiler chicken; growth; carcass yield.

1. INTRODUCTION

Several research investigations have lucidly indicated that nutrition can play a significant role to prevent human health-related problems. In a study involving 185 countries in 2015 it was stated that for developed nations, global average total protein per capita intake was 78.2 g/day, ranging from 61.0 g/day in the Middle East and North Africa to 92.5 g/day in Asia [1]. While, the mean total protein intake was greater than 46 g/day in all 185 countries, for developing nations global animal protein intake per capita varied from 38.3 g/day to 42.8 g/day in Latin America and the Caribbean, while Bangladesh and Nepal with values of 7.2 g/day and 10.1 g/day, respectively had the lowest mean national animal protein intake. Differences in the consumption pattern are visible, with developed nations exhibiting relatively higher levels of consumption than developing countries. Currently, protein demand for the 7.3 billion inhabitants of the world is approximately 202 million tonnes globally [2]. It has reported that improvement in economic well-being, causes a paradigm shift to high animal protein intake, and that protein in food and beverages are animal-based proteins: meat, poultry, seafood, eggs, and dairy products and plant-based proteins: legumes, vegetables, grains, nuts, and seeds [3].

Declining food consumption in most developing nations, accompanied with low protein intake manifests in hunger which several countries are trying to mitigate [4]. According to [5], increasing protein consumption could benefit majority of people in developing countries in order to achieve food security. The Kingdom of Lesotho, a lower-middle income country [6], is a small mountainous landlocked country in Southern Africa with a small population of about 2.14 million [7]. Despite the little contribution of agriculture to the nation's gross domestic product (GDP), it remains an important source of income for the majority of the people who are mostly rural residents [8]. A worrisome national nutrition state characterized by high instances of stunting in kids underneath age of five years, deficiency of micro nutrients in kids, adolescents and adults, overweight and obesity in certain parts of the population, and the surging evidence of diet related non-communicable diseases that are affecting lives and imposing an expense on the healthcare budget [9]. According to [10], protein from meat for Lesotho was 9.5 g per person per day. Poultry is known to have the capacity to be an amenable animal species for a high turn-over of table meat. However, most poultry farmers are faced with high feed costs resulting in a dwindling poultry industry and its inability to generate sufficient meat to satisfy the consumers demand. Consequently, there is a heavy reliance on importation of poultry meat to mitigate the supply gap [11]. The use of in-feed antibiotic growth promoters in livestock diet is a threat to consumers' health due to their negative impact on meat quality and has become an issue of global concern [12]. The need for identification of natural plant resources with important nutrient potential to promote growth, enhance meat quality and health of broiler chickens now becomes critical. Rosehip possesses several bioactive compounds some of which are essential nutrients for broiler chickens, which if available to them can enhance meat quality for safe human consumption. According to [13], rose plants produce fruits rich in polyphenols, vitamins A, C, and E, essential fatty acids, dalactolipid, minerals (Ca, Mg, K, S, Se, Mn, and Fe), as well as other bioactive components. It has been reported [14] that the high antioxidant power in rosehip is mainly related to its vitamin C content. Hence, this study was aimed at evaluating the utilisation of rosehip (*Rosa canina* L) fruit as a dietary supplement in broiler chicken production and effect on their productive performance.

2. MATERIALS AND METHODS

2.1 Experimental Site and Location

The research was undertaken at the National University of Lesotho Livestock Farm located in Roma, about 35 kilometres from Maseru the capital of the Kingdom of Lesotho. Roma is found in the Lowlands of Lesotho with altitude ranging from 1500-1800 m, and annual rainfall ranging from 600-900 mm [15]. The climate in this area varies between the hot and cold months whereby winter is the coldest season which starts from May to August, with temperature dropping as low as -1ºC, and summer the hottest season is experienced from September to April and the temperature can be as high as 28ºC [16].

2.2 Experimental Test Ingredient Processing and Diets

Undecorticated rosehip fruit of *Rosa canina* cultivar was harvested when fully ripened from the ranges where it naturally grows and air-dried till its reddish colour changed to dark-reddish, which signified about 90% moisture loss. It was milled, and thereafter thoroughly mixed with the commercial feed for each growth phase at the rate of 0, 100, 200, and 300 g/100 kg to give diets T_0, T_{100}, T_{200}, and T_{300}, respectively.

2.3 Proximate Analysis

The proximate nutrients in the milled sample of undecorticated rosehip fruit were determined using [17] and the metabolisable energy calculated (Table 1) using [18]. The proximate composition and metabolisable energy of the commercial diets were also determined to verify the nutrients information printed on the feed tags (Table 2).

2.4 Experimental Animals, Management and Design

A total of 204-day-old Cobb 500 broiler unsexed chicks were used in a 42-day feeding trial. They were kept in a deep litter ¾ walled poultry house to mitigate the effect of cold wind

prevalent in Lesotho, and poultry waste litter used was disinfected. Fluorescent lighting system was provided while, wall mounted Tempadair WH Fan Range electric heater and gas heater were used during brooding to provide and regulate poultry house temperature. Their average live body weight was 35.4 g, and chicks were randomly divided into 4 groups on similar body weight basis. A group was randomly allocated to one of the 4 different experimental diets, T_0, T_{100}, T_{200}, and T_{300} containing commercial feed brand mixed with rosehip feed supplement at the rate of 0, 100, 200 and 300 g/100 kg, respectively (Table 3). Each experimental group had 3 replicates of 17 birds each kept in a 1.5 m^2 pen at a stocking density of 0.088 m^2. The experiment was a completely randomized design. Drinking water was served with manual poultry plastic drinkers together with an anti-stress pack on arrival of the chicks. Plastic tray feeders were first used for about seven days, and thereafter manual plastic conical feeders. Experimental diets along with drinking water were served *ad libitum* for the feeding period which covered the starter, grower and finisher phases. The feed tags on the commercial feed provided qualitative and quantitative information on dietary nutrients contained.

2.5 Data Collection

Data was collected on the following:

2.5.1 Growth performance indices

The initial and final live body weight of the chickens per replicate taken at the start and termination, along with live body weight per replicate weekly. The body weight gain (BWG) was calculated per replicate weekly by the difference between the live body weight of the current week (LBW_c) and body weight of the previous week (LBW_p);

$$\text{Average BWG} = \frac{LBWc - LBWp}{NO\ of\ birds}.$$

Feed intake (FI) was determined by the difference between the weight of feed supplied (FS) and the weight of the feed leftover (FL) on weekly basis (FI = FS – FL) and feed conversion ratio (FCR) computed as FCR = $\frac{FI}{BWG}$. Protein intake (PI) was calculated as feed intake (FI) multiplied by percent crude protein (% CP) in the diet ($PI = FI * \%\ CP$) and protein efficiency ratio calculated as $\frac{BWG}{\%\ CP\ intake}$.

Mortality in any replicate was recorded when it occurred.

Table 1. Nutrient Composition of Undecorticated Rosehip (*Rosa canina* L) Fruit (DM)

Nutrients	%
Dry matter	89.40
Crude protein	10.29
Crude fibre	40.83
Crude fat	4.25
Ash	4.03
Nitrogen free extract	40.60
Calcium	0.94
Phosphorus	0.50
Energy (kcal ME/kg)	728.38

Metabolisable energy = (37 x % Crude protein) + (81.8 x % Crude fat) + (35.5 x % Nitrogen free extract) ------[18].

Table 2. Nutrients in the Commercial Experimental Diets

Nutrients (% DM)	Starter crumbs		Grower mash		Finisher mash	
	Laboratory analysis	1Feed tag	Laboratory analysis	2Feed tag	Laboratory analysis	3Feed tag
Dry matter	85.30	88.00	89.43	88.00	88.60	88.00
Crude protein	26.17	25.00	23.28	20.48	19.95	20.45
Crude fibre	6.30	5.68	6.30	6.82	6.32	7.95
Crude fat	2.94	3.41	3.00	2.84	2.67	3.41
Total lysine	1.62	0.97	1.70	1.14	1.84	1.02
Calcium (%)	1.62	1.36	1.41	1.36	0.63	1.36
Phosphorus (%)	0.57	0.68	0.38	0.63	0.37	0.80
Methionine	0.69	-	0.50	-	0.51	-
NaCl	0.47	-	0.53	-	0.49	-
Ash	4.02	-	5.34	-	4.89	-
Nitrogen free extract	60.57	-	66.89	-	66.17	-
Metabolisable energy (Kcal ME/kg)	3359.02	-	3481.36	-	3305.59	-

Metabolisable energy = 37 × % CP + 81.8 × % EE + 35.5 × % NFE ………………[18]

1,2,3 nutrients in commercial experimental diets

Table 3. Experimental Diets Fed to the Broiler Chickens

Growth phase	Mixture of Feed and Rosehip supplement	Experimental Diets			
		T1	T2	T3	T4
Starter	Feed (kg)	100	100	100	100
	Rosehip supplement (g/100 kg)	0	100	200	300
Grower	Feed (kg)	100	100	100	100
	Rosehip supplement (g/100 kg)	0	100	200	300
Finisher	Feed (kg)Rosehip supplement	100	100	100	100
	(g/100 kg	0	100	200	300

T1 – Control diet with 0 g/100 kg rosehip supplement, T2 – Diet containing 100 g/100 kg rosehip supplement, T3 – Diet containing 200 g/100 kg rosehip supplement, T4 – Diet containing 300 g/100 kg rosehip supplement

2.5.2 Carcass and visceral indices

Carcass evaluation was done on the 42nd day with selected two broiler chickens per replicate of average live body weight similar to the treatment average and slaughtered for carcass evaluation as described by [19]. Prior to selection, the chickens were deprived of feed for 18 hours and the fasted live body weight was taken. Slaughtered chickens were dipped in hot water

(70 ºC) for about 20 seconds to allow for easy plucking of feathers. Evisceration of chickens followed after plucking and the eviscerated weight was recorded. The carcass was cut into prime parts; breast, thigh, drumstick, wing, neck and back, and weighed. The carcass cuts were expressed relative to the dressed weight, and dressing percentage was calculated using formula

$$Dressing\ percentage = \left(\frac{dressed\ weight}{fasted\ live\ body\ weight}\right) * 100$$

The weight of the empty gizzard, kidney, liver, pancreas, proventriculus, lungs and spleen were taken and expressed relative to the live body weight. The morphometry of small intestine, large intestine, caeca and the whole gastro-intestinal tract was taken.

2.6 Statistical Analysis

All the growth and carcass yield data were entered in Microsoft Excel Spreadsheet. The response variables were analysed as one-way ANOVA [20] version 20, with four dietary treatments as the main effects. Significantly different means were separated using Least Significance Difference (LSD).

3. RESULTS AND DISCUSSION

3.1 Nutrient Composition

The result of the nutrient analyses of the undecorticated rosehip fruit is in Table 1. It contained 89.40 % dry matter, 10.29 % crude protein, 40.83 % crude fibre, 4.25 % crude fat, 4.03 % ash and 40.60 % nitrogen free extract. Calcium content was 0.94 %, 0.50 % phosphorus and the calculated metabolisable energy was 728.38 kcal/kg. This proximate composition of *Rosa canina* showed a little variation compared to 92.32% DM, 10.53% CP, 37.58% CF and 4.25 % crude fat [21]. The crude fibre content of rosehip fruit in the current study is high because it was the undecorticated fruit that was used. This has resulted to reduction of nitrogen free extract and consequently the low energy of rosehip fruit. It has been reported that poultry needs a definite quantity of dietary fibre in order for appropriate gut physiological activities to occur [22]. *Rosehip* Ca level in the current study is lower, while P level was higher than 1.05 % to 1.22 % and 0.09 - 0.13 %, respectively [23].

The nutrient compositions of the commercial feeds on the feed tags and as determined in the laboratory are on Table 2. Variations were observed in the dry matter, crude protein, crude fibre, crude fat, total lysine, calcium and phosphorus contents between the laboratory determinations and the values on the feed tag in starter crumbs, grower and finisher mash. In starter crumbs, the laboratory determined dry matter was 85.30 %, lower than 88.00 % dry matter in feed tag, while in the grower mash and finisher mash, the dry matter values were comparable. There was a decrease in the laboratory determined crude protein values of the feed from 26.17 % in starter crumbs to 23.28 % in grower mash and 19.95 % in the finisher mash. This trend of decrease in crude protein was also observed on the feed tags. Thus, the dietary crude protein requirement of broiler chickens decreased as they became older. The level of crude protein was adequate for starter, grower and finisher phases in broiler production.

For broiler starter, grower and finisher, 23 %, 22 % and 20 %, respectively have been recommended [24]. The dietary crude fibre values determined in the laboratory were similar with a range of 6.30 to 6.32 % unlike the feed tag values which increased from 5.68 % to 7.95 % as the feed type changed from starter to finisher mash. Dietary fibre is considered an anti-nutritional factor because of its adverse effects on feed intake and nutrient digestibility [25]. It is obvious therefore that the dietary crude fibre in the study could retard the growth of the broiler chickens. Lower levels of crude fibre (≤ 5%) is recommended for broiler chickens irrespective of the stage of growth [26] to avoid growth reduction. The dietary crude fat determined in the laboratory ranged from 2.94 to 3.00 %, whereas it was 2.84 to 3.41 % on the feed tag.

The crude fat values in both were lower than the recommended range of 5.0% to 6.0% [27]. Lower dietary fat will decrease overall feed energy and broiler growth. Whereas, dietary fat reduces the passage rate of the digesta through the alimentary canal, thereby causing higher nutrient absorption and utilization, higher dietary fat may stimulate the onset of oxidative rancidity fast. Total lysine in the three diets differed with the feed type and increased from 1.62 % in the starter crumbs to 1.84 % in the finisher mash in the laboratory analyzed samples. The laboratory values of total lysine were higher than the tag values which varied from 0.97 % to 1.14 %, and the recommended values of 1.44%, 1.25% and 1.05% for broiler starter, grower and finisher, respectively [28]. The laboratory determined dietary methionine was also higher than the recommended values of 0.51% (starter), 0.45% (grower) and 0.39% (finisher) by [28], thus eliminating the possibility of lysine and methionine being limiting amino acid. Calcium in the experimental diets determined in the laboratory decreased from 1.62 % to 0.63 % as the feed type changed from starter crumbs to finisher mash, whereas on the feed tag it was 1.36 % Ca for each of the diets. The amounts in the diets were adequate for broiler production. It has been reported that the Ca requirements of broiler chicken are about 0.60 % [29]. The dietary phosphorus in the laboratory feed analysis also tended to decrease, from 0.57 % to 0.37 %, whereas on the feed tag, it increased from 0.68 % to 0.80 %. The values reported in the current study did not vary much 0.48 to 0.64 % phosphorus [30]. Low Ca:P may adversely affect calcium balance, which subsequently may increase the risk of bone fracture and osteoporosis. Currently broiler diets are formulated on the basis of total calcium (Ca) and available phosphorus (aP), with a ratio of 2:1 being maintained between Ca and aP. The Ca and P values in both the laboratory determinations and on the feed tags did not perfectly fit into the Ca:P ratio of 2:1 requirement. Major minerals like calcium and phosphorus are vital in broiler production as they assist in the structural functioning of broiler chickens, and aberrations affect bone health. The dietary salt (NaCl) content from the laboratory analysis ranged between 0.47 and 0.53 % from starter to finisher phase and was adequate for broiler production based on 0.50 % recommended by [24]. The ash content of the feeds differed with feed type and ranged between 4.02 and 5.34 %. The values are higher than 2.50 % recommended by [24]. Higher ash intake reduces feed utilization efficiency and excess ash content can also cause bone and joint problems in growing poultry [31]. The calculated dietary energy had a close range of 3305.59 Kcal ME/kg to 3481.36 Kcal ME/kg, and above the range of 3010 kcal/kg to 3225 kcal/kg stated as the requirement for broiler chickens [28].

3.2 Growth Performance

The effect of undecorticated rosehip fruit dietary feed supplement on broiler chicken growth performance over a 42-day feeding trial is in Table 4. The result showed that rosehip fruit, used as a phytogenic feed additive had significant (P<0.05) effect on feed intake, protein intake and mortality rate, while the final body weight, body weight gain, feed conversion ratio and protein efficiency ratio were not affected significantly (P>0.05). Some authors [21] reported that the average daily weight gain was not different between groups with the use of oregano and rosehip as a supplement in broiler chicken diet, similar to the result in the present study with a differential weight gain of 2.31 g/bird/day. However, the finding by [32] of a significant difference in body weight gain of broiler chickens fed basal diet mixed with rosehip supplement under cold stress, with the highest BWG recorded at 20 g/kg and 30 g/kg rosehip levels is not consistent with the present result. The difference in the body weight gain obtained was possibly due to the undecorticated rosehip fruit used, which caused elevated dietary fibre, and reduction in the utilisation of nutrients for growth by the chickens in the present study. A study reported that feed conversion ratio of rosehip treatment groups was similar to the control as in this study [33]. The protein efficiency of broiler chickens fed undecorticated rosehip fruit supplement was comparable among all the dietary treatments. This showed that 0 to 300 g/100 kg rosehip dietary supplement did not affect nutrient utilisation by broiler chickens.

Broiler chicken feed intake tended to reduce from 71.52 to 64.93 g/bird/day with the increase in the rosehip concentration in their basal diets from 100 to 300 g/100 kg. With the exception of the feed intake of the birds in T2 (71.52 g) which was significantly (P<0.05) higher than the control group T1 (67.04), there was no significant (P>0.05) difference in the mean daily feed intake among dietary treatments T1, T3 and T4. The protein intake trend followed the same order as feed intake. Thus, only the protein intake of the birds in T2 (13.78 g) was significantly (P<0.0.5) higher than the control group T1 (12.97 g), dietary treatments T1, T3 and T4 did not differ significantly (P>0.05) in the mean daily protein intake. This result is consistent with [34]

who found that the use of spices, herbs and plant extracts in poultry production improved feed intake. Broiler chickens receiving 100 and 200 g/100 kg rosehip supplement had higher intake of feed and protein than the control group. A possible reason for the significant decrease in feed intake, as rosehip supplement increased beyond 200 g/100 kg diet, can be the higher crude fibre in rosehip fruit which can negatively impact on the feed quality.

Table 4. Effect of experimental diets on growth performance of broiler chickens

Performance Indices	Experimental Diets				
	T1	**T2**	**T3**	**T4**	**SEM**
Initial body weight (g/bird)	36.55	34.86	35.28	34.94	0.43
Final bodyweight (g/bird)	1754.69	1840.04	1797.08	1743.00	27.38
Body weight gain (g/bird/day)	40.91	42.98	41.95	40.67	0.65
Feed intake (g/bird/day)	67.04^{b}	71.52^{a}	68.15^{ab}	64.93^{b}	0.90*
Feed conversion ratio	1.65	1.67	1.63	1.60	0.02
Protein intake (g/bird/day)	12.97^{b}	13.78^{a}	13.14^{ab}	12.59^{b}	0.16*
Protein efficiency ratio	3.15	3.12	3.19	3.23	0.04
Mortality (%)	5.88^{ab}	3.92^{b}	1.96^{b}	9.80^{a}	1.14*

$^{a,\ b,}$ Means with different superscripts in the same row are significantly different (P<0.0.5), SEM = Standard Error Mean,

T1 – Control diet with 0 g/100 kg rosehip supplement, T2 – Diet containing 100 g/100 kg rosehip supplement, T3 – Diet containing 200 g/100 kg rosehip supplement, T4 – Diet containing 300 g/100 kg rosehip supplement

The chickens irrespective of the experimental treatments had a steady and similar increase in weekly live body weight throughout the feeding trial (Fig. 1). The consistent and similar increase in weekly live weight of the broiler chickens obtained across the dietary treatments showed that the undecorticated rosehip fruit supplement at the rate of 100 g/100kg diet, did not cause body weight depression. The weekly feed intake of the broiler chickens is shown in Fig. 2. A similar pattern in weekly feed intake occurred in the four experimental groups from week one to week six. The slight reduction in feed intake between week three and week four

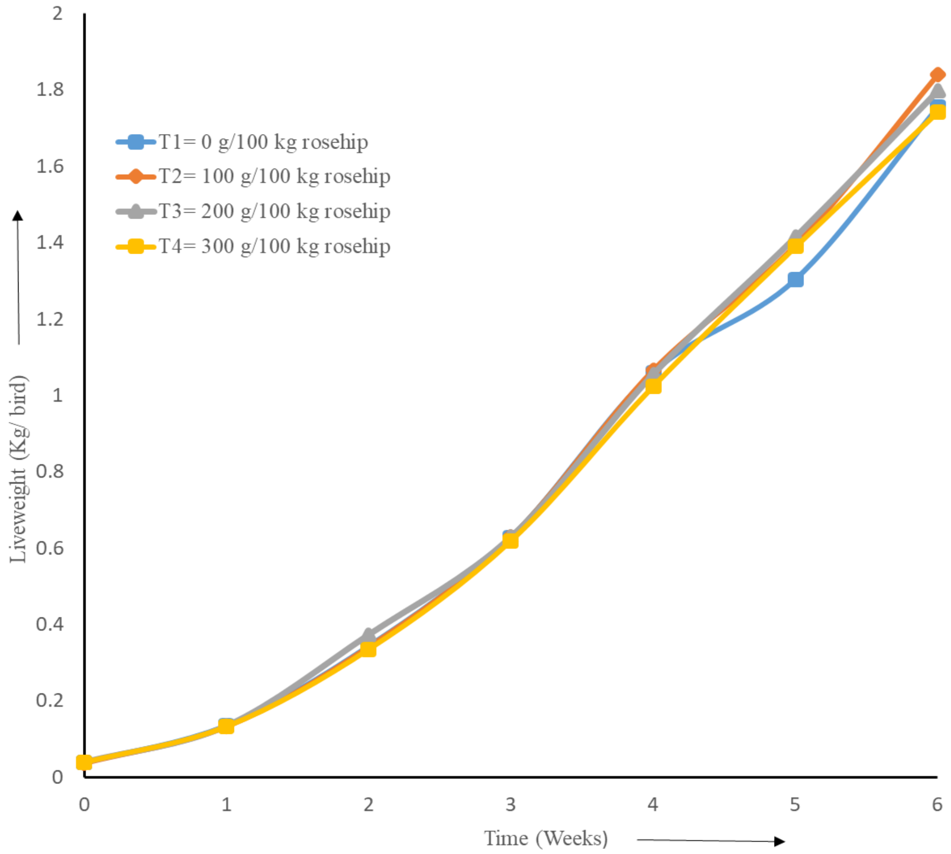

Fig. 1. Mean weekly live body weight of broiler chickens fed rosehip supplement

irrespective of the treatments, and the very sharp decrease in feed intake from week five to week six was likely due to the response of the birds to the varying weather conditions of intermittent rain precipitations which characterized the period. Mortality occurred and may not be due to the undecorticated rosehip fruit supplement, because of the distribution irrespective of the treatment groups. In the control group 5.88% mortality was recorded and was higher than in the 100 g/100 kg and 200 g/100 kg treatments. Furthermore, there was no particular order in mortality across the treatments. The result is similar to the finding by [35], that the control group recorded mortality with the addition of herbal spices to the basal diet of broiler chickens.

3.3 Carcass Yield

The inclusion of rosehip as supplement in the experimental diets of broiler chickens had a significant (P<0.05) effect on the dressed weight (DW), and % DW of wing and drumstick (Table 5). Broiler chicken dressed weights of 1.35 kg (0 g/100 kg), 1.39 kg (100 g/100 kg) and 1.38 kg (200 g/100 kg) were comparable, but relatively higher than at 1.28 kg (300 g/100 kg). This showed the possibility of decrease in broiler chicken dressed weight at higher supplementation level. However, the 12.08% DW of wing and 13.65% DW of drumstick were superior to the control. Significant drumstick value compared with control group was obtained when broiler's basal diet was supplemented with phytogenic feed additive [36]. The Dressing percentage obtained varied from 80.03 to 80.83, and did not differ significantly (P>0.05) irrespective of dietary groups. Dressing percentage (carcass yield) is defined as the proportion of ending live weight obtained after animals have been stunned, exsanguinated, skinned/scalded and eviscerated [37]. Dressing percentage (DP) therefore is a critical carcass measure. It was reported that treatment with phytogenic feed additives did not influence either dressing percentage or proportions of the valuable muscles from breast and thigh in total carcass as observed in this study [33]. No significant variation in carcass cuts was observed when rosehip supplement was fed to broiler chickens [32].

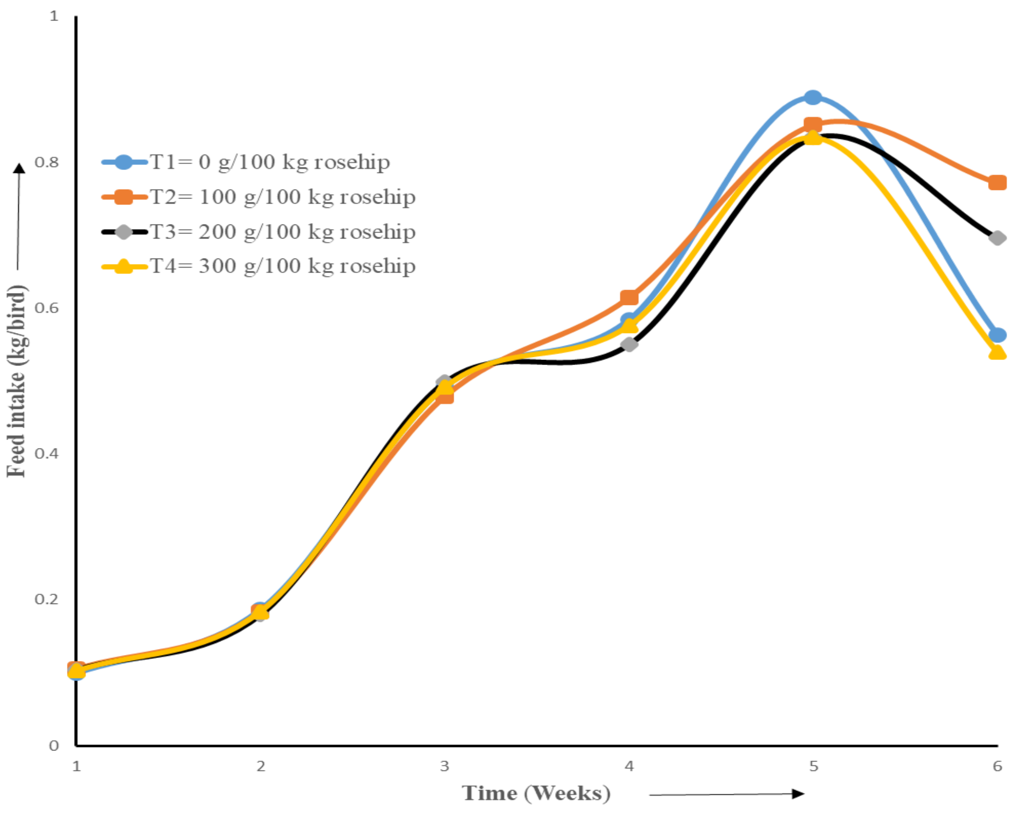

Fig. 2. Mean weekly feed intake of broiler chickens fed rosehip supplement

3.4 Visceral Organs and Gastrointestinal Tract Morphometry

The experimental treatments had significant (P<0.05) effect on the % LW of heart, kidney, pancreas, proventriculus and spleen of the birds but insignificantly (P>0.05) affected % LW of the abdominal fat, empty gizzard and the liver. Visceral organs are necessary for efficient physiological functioning of various biological processes responsible for the wholesomeness of all organisms. Broiler chickens on rosehip supplement of 300 g/100 kg appeared to have relatively bigger pancreas (0.13 % LW) and a resultant least body weight gain (40.67 g/day). Pancreas is an important organ in the digestive system, producing the enzymes which hydrolyze major nutrients into small monomers that can be absorbed into the blood or lymph. The increased size of pancreas thus signaled deceleration of nutrient utilisation with the attendant lower growth rate. The heart helps with proper blood circulation which in return helps to prevent the prevalence of ascites in broiler production. The rosehip fruit dietary supplement increased the dietary fibre of the feed consumed at higher level of supplementation. This would have caused increased metabolic activity for nutrients optimization, and eventually increased heart beat and the % LW of the heart (0.79) of the birds as observed in this study. The fibrous nature of the dietary supplement possibly induced the comparatively bigger proventriculus of 0.41% LW at 200 g/100 kg and 0.42% LW at 300 g/100 kg diets because of its storage and glandular functions. The significant trend of the effect of rosehip fruit dietary supplement on the spleen is similar to that of the proventriculus and the heart. It has been reported [21] that the weight of liver and spleen were significantly affected by the addition of phytogenic feed additives to broilers basal diet but oregano and rosehip supplements had no effect on pancreas and heart weights. The abdominal fat was unaffected significantly (P.>0.05), which is similar to the finding of [38] with vitamin C supplementation to broiler chickens.

The experimental treatments had significant (P<0.05) effect on the morphometry of large intestine and caeca, whereas the length of the entire tract and small intestine did not vary significantly (P>0.05). Both % GIT length of the large intestine and the caeca reduced from 3.29% to 2.15% and 0.64% to 0.44%, respectively with increase in the rosehip fruit

Table 5. Effect of experimental diets on carcass yield, visceral organ weight and intestinal tract morphometry of broiler chickens

Carcass cuts	Experimental Diets				
	T1	T2	T3	T4	SEM
Fasted live weight (kg)	1.79^{a}	1.84^{a}	1.79^{a}	1.69^{b}	0.02*
Dressed weight (kg)	1.35^{a}	1.39^{a}	1.38^{a}	1.28^{b}	0.01*
Dressing percent (%)	80.68	80.83	80.03	80.04	0.30
Wing (% DW)	12.00^{a}	10.99^{b}	11.73^{ab}	12.08^{a}	0.16*
Drumstick (% DW)	13.26^{a}	11.84^{b}	13.53^{a}	13.65^{a}	0.20*
Thigh (% DW)	15.28	15.86	14.81	14.24	0.36
Back and neck (% DW)	29.59	26.43	28.31	30.60	0.75
Empty gizzard (% LW)	2.27	1.85	2.26	2.09	0.08
Liver (% LW)	2.03	1.94	2.00	1.73	0.07
Heart (% LW)	0.69^{b}	0.65^{b}	0.79^{a}	0.79^{a}	0.02*
Kidney (% LW)	0.01	0.01	0.01	0.01	0.00
Pancreas (% LW)	0.10^{bc}	0.11^{ab}	0.09^{c}	0.13^{a}	0.01*
Proventriculus (% LW)	0.40^{b}	0.38^{c}	0.41^{ab}	0.42^{a}	0.00*
Spleen (% LW)	0.12^{bc}	0.11^{c}	0.14^{a}	0.13^{ab}	0.00*
Abdominal fat (% LW)	2.04	1.99	2.28	1.80	0.09
GIT (m)	2.40	2.13	2.67	2.26	0.05
Small intestine (% GIT)	85.53	89.04	86.33	90.15	1.48
Large intestine (% GIT)	2.92^{ab}	3.29^{a}	2.42^{b}	2.15^{b}	0.15*
Caeca (% GIT)	0.51^{b}	0.64^{a}	0.57^{ab}	0.44^{bc}	0.02*

^{a,b,c} Means with different superscripts in the same row are significantly different (P<0.0.5), SEM = Standard Error Mean,

T1 – Control diet with 0 g/100 kg rosehip supplement, T2 – Diet containing 100 g/100 kg rosehip supplement, T3 – Diet containing 200 g/100 kg rosehip supplement, T4 – Diet containing 300 g/100 kg rosehip supplement

supplement from 100 to 300 g/100 kg. However, [39] reported that addition of higher fibre in broiler's basal diet had a significant effect on the length of the small intestine. The decrease in % GIT length of large intestine and caeca can be associated with the decrease in both the feed intake and final body weight as rosehip fruit supplement increased from 100 to 300 g/100 kg. According to [40] that digestive tract of modern broiler chickens is depended on the growth rate of the birds and besides the effect of feed intake, changes in digestive tract functionality is related to diet composition and feeding system.

4. CONCLUSION

It is concluded from this study that:

4.1 Undecorticated rosehip fruit is high in crude protein, crude fibre and low in energy.

4.2 Undecorticated rosehip fruit at 100 to 300 g/100 kg dietary supplementation did not enhance the growth of broiler chickens but, gave high dressing percentages of 80.03% to 80.83% comparable to 80.68% in the control group, and decreased percentage large and small intestine of the tract significantly.

5. RECOMMENDATIONS

Undecorticated rosehip fruit can be fed as dietary supplement at the rate of 100 to 300 g/100 kg to produce broilers of high dressing percentage, and further studies are recommended to evaluate the effect of processed undecorticated rosehip fruit on broiler chickens.

ACKNOWLEDGEMENT

We acknowledge the Department of Animal Science, The National University of Lesotho, Roma for funding the purchase of the experimental materials.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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