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Effect of Sex, Locations and Seasons on Nutritional Status of Non-descript Free-range Scavenge Chicken of Assam, India

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ABSTRACT

Background: The inferior productivity of non-descript free-range scavenge chicken might be due to poor nutrition. Further, nutritional status of such chicken varied with seasons, locations *etc*. In the present study, nutritional status of indigenous free-range chicken was investigated in different seasons and in different agro-climatic zones of Assam to formulate nutritional strategies to optimize their production potential.

Methods: Altogether, 160 chickens (80 males and 80 females) of 7 to 10 months of age were collected randomly from different agro-climatic zones *viz*. Lower Brahmaputra Valley Zone (LBVZ), Upper Brahmaputra Valley Zone (UBVZ), Central Brahmaputra Valley Zone (CBVZ) and North Bank Plain Zone (NBPZ) of Assam during different seasons *viz*. Pre-monsoon (PRM), Monsoon (MON), Post-monsoon (PTM) and Winter (WIN) seasons and were slaughtered and their crop contents were separated out for physical and chemical analysis to assess the nutritional status of them.

Result: The grains and by-products were significantly (P<0.05) higher during PTM season. The green forages were significantly (P<0.05) higher in CBVZ than other zones. The DM contents was significantly (P<0.05) higher in PTM season than other seasons. The proportions of CP were significantly (P<0.05) higher during MON season. Both DM and CP contents were significantly (P<0.05) higher in LBVZ zone. It could be concluded that the scavenged feed resource base varied with seasons and locations and was alsodeficient in some major nutrients in different locations and seasons and hence could not be fulfil nutritional requirement of free-range chicken. Therefore, it is very imperative to provide strategic incremental feeds along with minerals to free-range chickens to improve their production potential.

Key words: Agro-climatic zones, Crop contents, Non-descript chicken, Proximate principles, Seasons, Sex.

INTRODUCTION

Free-range scavenging chicken is an indispensable part among resource-poor and under-privileged rural communities of low-income food-deficit countries throughout the world. They play a major role in providing income, nutritional security and socio-cultural values among the rural poor (Alders and Pym, 2009). Backyard chicken farming has been a potential tool to alleviate poverty, to eradicate malnutrition, to empower women and to employ family labours among rural tribals in India (Chatterjee and Rajkumar, 2015; Rajkumar and Rama Rao, 2015; Islam *et al.*, 2021). Despite their multi-faceted utility, less attention has been paid by researchers and policy makers for overall development of such non-descript type of free-range chicken. Moreover, the production potential of such chicken is much lower than intensive commercial chicken due to inferior genetic make-up, sub-optimal nutrition, improper management and in-appropriate disease control programme. In addition to proper management and disease control programme, nutrition could play a vital role in achieving better productive and reproductive outputs in scavenging chicken,as the local scavenging chickens are generally deficient in their nutritional profile (Mwalusanya *et al.,* 2002). Moreover, the nutritional status of scavenging chicken varies with seasons and locations as the scavenging feed resource base (SRFB) differs with seasons and locations (Goromela *et al*., 2008). Hence, most of the farmers provide supplemental feed to their scavenged chicken in order to meet the nutritional requirement of chicken as the availability of scavenged feed resource base varies with different seasons and regions (Rajkumar *et al*., 2021). It would be unwise to formulate feeding strategies for free range chicken without knowing the actual nutritional status of scavenged chicken.

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Hence to develop a comprehensive feed formula for scavenging chicken,the present study was planned with an objective to assess the nutritional status of such non-descript type of chicken under free-range scavenge condition by analyzing physical and composition of crop ingesta in different seasons and agro-climatic zones of Assam, India

MATERIALS AND METHODS

Locations and seasons of the study

The latitude of Assam, India is 26.2006° N and the longitude is 92.9376° E. The climate is typically "Tropical Monsoon Rainforest Climate" with high humidity and heavy rainfall. The paddy is the most important and staple food crop, while tea is the principal cash crop grown in the state of Assam. It has six agro-climatic zones. The present study was carried out in four agro-climatic zones *viz*. Upper Brahmaputra Valley Zone (UBVZ), Lower Brahmaputra Valley Zone (LBVZ), North Bank Plain Zone (NBPZ) and Central Brahmaputra Valley Zone (CBVZ). One district from each zone was selected on the basis of population of non-descript type of chicken. The district, which had highest such type of chicken as per 20th Livestock Census, 2019 (DAHD, 2021) was selected from each zone. Thus, a total of four districts were selected as shown in the Table 1. The study was carried out in all four seasons *viz*. pre-monsoon (March-May), monsoon (June-September), post-monsoon (October-November) and winter (December-February) seasons during 2023-24. The temperature in different seasons and annual average rainfall in different zones are shown in Table 2.

Selection of birds

The indigenous chickens reared under free-range scavenging system having 7 to 10 months of age were considered for the study. The birds were purchased/ collected from selected farmers from each zone based on their experience in indigenous chicken farming and accessibility to the investigator. Altogether 40 farmers (10 from each zone) were selected randomly for this purpose. From each zone and each season 10 (1 chicken per farmer) such scavenged chickens (5 cocks and 5 hens)were randomly selected. The selected birds were collected directly from the selected farmer's household between 4 to 6 pm.In this manner 40 chickens were collected during one season from all zones. Thus, altogether 160 chickens (40 chickens per season ×4 zones) were collected for the whole study and were utilized for crop sample collection.

Collection of crop contents

The birds so collected were then slaughtered on the spot by severing the jugular vein after recording their individual body weights. Then, each bird was eviscerated, the crop was separated and preserved in ice for further laboratory analysis.

Physical analysis of crop contents

For physical analysis, contents were separated out from the crop, kept in aluminum foil and weighed before physical analysis. The different feed items found in the crop of each

Table 1: Selected agro-climatic zones with respective districts.

Agro-climatic zones	Districts selected
Upper Brahmaputra Valley Zone (UBVZ)	Sivasagar
Lower Brahmaputra Valley Zone (LBVZ)	Dhubri
North Bank Plain Zone (NBPZ)	Sonitpur
Central Brahmaputra Valley Zone (CBVZ)	Nagaon

Table 2: Temperature and rainfall of different agro-climatic zones during different seasons.

Zones	Weather data	Seasons				Average annual rainfall (mm)
		Pre-monsoon (PRM)	Monsoon (MON)	Post-monsoon (PTM)	Winter (WIN)	
LBVZ	Temperature (°C)	15.5-31.6	24.2-32.0	15.5-30.1	8.6-26.2	2238.6
	Rainfall (mm)	42.6-410.9	467.0-652.8	14.3-167.8	8.0-18.1	
UBVZ	Temperature (°C)	16.0-31.0	24.0-32.0	16.0-30.0	10.0-25.0	1478.1
	Rainfall (mm)	102.0-368.0	316.0-487.0	30.0-121.0	13.0-70.0	
NBPZ	Temperature (°C)	17.0-30.6	24.7-32.3	16.5-27.6	11.3-25.5	1851.0
	Rainfall (mm)	67.0-297.0	189.0-343.0	24.0-116.0	8.0-16.0	
CBVZ	Temperature (°C)	21.6-32.2	24.8-31.4	21.3-31.5	18.2-30.0	2036.3
	Rainfall (mm)	0.0-13.0	335.0-839.0	13.0-77.0	0.0-3.0	

Source: https://www.rkbassam.in.

bird were identified visually and were separated physically with the help of forceps into different categories as shown in the Table 3. The contents after separating physically under different categories were sundried and weighed.

Chemical analysis of crop contents

For chemical analysis, the dried contents were mixed together and ground after the grits and other inanimate objects were removed from the sample. The ground crop contents were analyzed for the proximate components of dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF) and ash as per standard method [9] while, calcium and total phosphorus were estimated as per the method described by (Talapatra *et al.,* 1940). The chemical analysis of the crop samples was carried out at the post-graduate laboratory, Department of Poultry Science, College of Veterinary Science, AAU, Khanapara, Guwahati in collaboration with National Research Centre on Pig, Rani, Guwahati.

Statistical methods

Variations of physical and chemical composition of crop content of birds with respect to different agro-climatic zone were analyzed as per standard statistical methods.Fixed effect general linear models were fitted with the datasets using PROC Univariate procedure of Statistical Analysis System (SAS 9.3) and the model of analysis of variance defined below

$$Y_{ijkl} = \mu + Z_i + S_j + G_k + (ZS)_{ij} + (SG)_{jk} + (GZ)_{ki} + e_{ijkl}$$

Where,

Y_{ijklm} = Observation of studied trait.

μ = Overall mean of the observed trait.

Z, S and *G* = Effects of i^{th} agro-climatic zone j^{th} season and k^{th} sex respectively.

ZS, SG and GZ = Interaction effects between agro-climatic zone and season; season and sex; and sex and agro-climatic zone respectively.

The residual error in the model is represented by $e_{ijklm}$with the assumption of normal and independently distributed with mean zero and variance σ^2_e. The analyzed data were expressed as Mean± SE. Whenever the effect was significant, the differences were tested for significance by Duncan's multiple range test (DMRT) as modified by (Kramer, 1957).

RESULTS AND DISCUSSION

Physical composition of crop content

Effect of season

The physical composition of the crop contents of free-range non-descript type of chicken is presented in the Table 4. The results indicated that the contents of grains and by-product along with kitchen wastes, green forages, insects and worms and indigestible miscellaneous particles of free-range chicken cropvaried significantly (P<0.05) across seasons. The grains and by-products were significantly (P<0.05) higher during PTM season followed by WIN, PRM and lowest during MON season. The kitchen wastes were higher (P<0.05) during PRM season followed by MON, WIN and PTM seasons. Higherproportions of green forages were recorded in MON season than other seasons. However, the corresponding values for green forages were comparable between PRM and WIN seasons. The proportion of insects and worms in the crop was also higher in MON season as compared to other seasons. Similarly, the quantities of indigestible miscellaneous particles were significantly (P<0.05) higher in MON and WIN seasons. However, the corresponding values during PRM and PTM were comparable between themselves.

Effect of location

The results revealed that there were no significant differences of contents like grains and by-products, kitchen wastes, insects and worms and indigestible miscellaneous particles across zones, while green forages were significantly (P<0.05) higher in CBVZ than other zones (Table 4). However, the corresponding values for green forages in LBVZ, UBVZ and NBPZ were statistically similar and did not show any significant differences. The study also indicated that the total intake also significantly higher in CBVZ and NBPZ as compared to other zones.

Effect of sex

The results also revealed that contents like kitchen wastes, green forages and indigestible miscellaneous particles significantly (P<0.05) differed between two sexes, while grains and by-products and insects and worms did not differ significantly between hen and cock (Table 4).The proportions of kitchen wastes, green forages and indigestible miscellaneous particle were higher in females

Table 3: Physical categorization of crop contents.

Categories	Feed ingredients/items
Grains	Whole paddy rice, broken rice, maize and seeds of grass.
Kitchen waste	Cooked rice, cooked pulses, vegetable trimming and stump, scale and stomach of fish, rice bran, egg shell *etc*.
Green forages	Grasses, plant materials, vegetable leaves and herbs
Insects and worms	Insects, ants, earthworms and flies
Indigestible miscellaneous particle	Paper products, polythene, pieces of brick, buttons, feathers, hairs, glass and unidentified ingredients

Table 4: Physical composition of crop contents in different seasons, locations and sexes.

Parameter	Season (Sn)	Zones (Zn)								Season (Sn)	Sex (Sx) Mean	
		LBVZ		CBVZ		UBVZ		NBPZ			Male	Female
		Male	Female	Male	Female	Male	Female	Male	Female	Means		
Grains and by-products	PRM	34.91±2.85	41.70±0.95	35.86±2.67	39.50±2.59	40.40±1.57	42.53±1.64	35.35±1.20	37.60±1.58	38.48^{c}±0.78	41.34^{A}±0.89	41.68^{A}±0.88
	MON	46.66±1.41	47.77±3.06	33.58±1.04	30.75±1.58	31.18±1.51	29.58±0.78	33.57±0.92	30.08±0.71	35.40^{d}±1.22		
	PTM	37.20±0.87	34.05±0.65	51.00±1.12	51.15±1.05	55.80±1.50	49.31±1.34	52.84±1.29	52.89±1.17	48.03^{a}±1.24		
	WIN	45.63±2.05	43.69±2.11	45.28±1.12	46.28±0.82	39.89±0.90	43.37±0.38	42.36±0.88	46.58±0.80	44.13^{b}±0.53		
	Zn Mean	41.45^{A}±1.02		41.68^{A}±1.29		41.51^{A}±1.36		41.41^{A}±1.35				
Kitchen wastes	PRM	52.69±1.36	39.51±1.80	48.76±2.48	43.83±2.98	42.55±1.27	36.62±2.10	49.55±1.27	44.14±1.15	44.71^{a}±1.01	41.29^{A}±0.84	37.42^{B}±0.86
	MON	33.33±1.88	28.60±2.03	43.85±0.89	46.19±1.62	46.13±1.19	45.84±1.49	42.16±0.64	47.65±1.41	41.72^{b}±1.14		
	PTM	45.53±1.36	43.83±1.17	31.63±0.98	29.81±0.80	30.71±0.81	25.91±1.06	30.17±1.24	28.01±1.14	33.20^{d}±1.15		
	WIN	39.66±2.16	38.30±1.94	36.68±1.24	34.11±0.97	47.91±1.68	33.39±0.68	39.38±1.00	33.02±0.86	37.81^{c}±0.86		
	ZnMean	40.18^{A}±1.24		39.36^{A}±1.20		38.63^{A}±1.30		39.26^{A}±1.26				
Greenforages	PRM	1.49±0.25	1.97±0.31	1.67±0.35	1.82±0.23	2.08±0.34	2.87±0.52	1.34±0.20	1.69±0.21	1.87^{b}±0.12	1.65^{A}±0.12	1.95^{B}±0.12
	MON	2.03±0.25	2.69±0.54	2.27±0.43	3.17±0.57	1.36±0.26	1.71±0.41	4.17±0.50	2.29±0.33	2.46^{a}±0.19		
	PTM	0.81±0.22	1.34±0.30	1.22±0.16	3.47±0.33	0.75±0.11	0.97±0.10	1.28±0.19	0.89±0.27	1.34^{c}±0.15		
	WIN	2.29±0.77	1.24±0.32	1.42±0.18	2.81±0.56	0.90±0.14	1.26±0.14	1.30±0.13	1.01±0.21	1.53^{bc}±0.16		
	Zn Mean	1.73^{B}±0.16		2.23^{A}±0.18		1.49^{B}±0.14		1.74^{B}±0.18				
Insects and worms	PRM	1.33±0.15	1.81±0.50	0.84±0.41	1.25±0.24	2.02±0.38	1.84±0.37	1.82±0.67	1.19±0.21	1.51^{c}±0.14	2.91^{A}±0.25	2.59^{A}±0.19
	MON	5.95±0.26	4.63±0.56	6.43±0.46	5.22±0.58	4.46±1.00	4.61±0.70	6.11±0.50	3.76±0.65	5.15^{a}±0.24		
	PTM	2.53±0.48	2.94±0.57	2.89±0.39	1.57±0.34	4.61±0.55	4.00±0.44	3.18±0.79	2.33±0.29	3.01^{b}±0.22		
	WIN	1.14±0.37	1.61±0.15	1.36±0.58	1.06±0.35	0.36±0.16	2.09±0.76	1.57±0.31	1.48±0.38	1.33^{c}±0.16		
	Zn Mean	2.74^{A}±0.29		2.58^{A}±0.35		3.00^{A}±0.31		2.68^{A}±0.30				
Indigestible miscellaneous particle	PRM	9.59±2.58	15.01±1.04	12.86±1.29	13.60±1.65	12.94±0.69	16.14±1.40	11.94±1.25	15.39±0.74	13.43^{b}±0.56	12.80^{B}±0.35	16.37^{A}±0.35
	MON	12.02±0.88	16.31±1.92	13.88±0.61	14.66±2.22	16.86±0.89	18.27±1.01	14.00±0.84	16.22±1.60	15.28^{a}±0.53		
	PTM	13.93±1.78	17.85±1.86	13.26±0.73	14.00±0.61	8.14±0.76	19.81±1.49	12.53±0.43	15.88±0.84	14.42^{ab}±0.65		
	WIN	11.28±0.24	15.16±0.53	15.27±0.86	15.76±0.65	10.94±1.03	19.89±0.21	15.40±1.00	17.92±0.60	15.20^{a}±0.50		
	Zn Mean	13.89^{A}±0.65		14.16^{A}±0.42		15.37^{A}±0.72		14.91^{A}±0.43				
Totalintake	PRM	22.78±0.47	23.32±0.21	23.84±0.24	24.12±0.35	22.02±0.63	22.72±0.62	25.46±0.65	25.04±0.26	23.66^{b}±0.23	24.77^{A}±0.23	24.51^{A}±0.25
	MON	25.54±0.41	25.14±0.41	26.66±0.68	25.80±0.55	24.84±0.58	25.62±0.42	26.50±0.34	26.06±0.23	25.77^{a}±0.18		
	PTM	24.54±0.40	22.38±0.52	26.40±0.36	28.32±0.88	26.66±0.63	26.94±0.73	26.62±0.37	24.90±0.93	25.85^{a}±0.34		
	WIN	26.56±0.56	24.78±1.08	22.80±0.63	22.40±0.50	22.08±0.91	20.90±0.89	23.08±0.57	23.66±0.80	23.28^{b}±0.36		
	Zn Mean	24.38^{B}±0.28		25.04^{A}±0.36		23.97^{B}±0.41		25.17^{A}±0.27				

Zone Mean and Sex mean with different superscripts between the columns with in a row for each parameters differs significantly (P<0.05)Seasons mean with different superscripts between the rows with in a column for each parameters differs significantly (P<0.05).

Table 5: Proximate principles of crop contents in different seasons, locations and sexes.

Parameter	Season (Sn)	Zones (Zn) LBVZ Male	LBVZ Female	LBVZ Male	LBVZ Female	LBVZ Male	LBVZ Female	LBVZ Male	LBVZ Female	Sn Mean	Sex (Sx) Mean Male	Sex (Sx) Mean Female
DM	PRM	48.55±0.46	49.74±0.53	48.06±0.68	48.82±1.01	48.98±0.58	49.78±0.65	48.13±0.84	50.48±0.31	49.07^{b}±0.25	49.67^{A}±0.27	49.41^{A}±0.30
	MON	51.81±0.48	50.65±1.24	49.94±0.62	47.02±0.80	45.54±1.13	46.36±0.51	48.55±0.83	45.85±0.62	48.21^{c}±0.44		
	PTM	49.25±0.57	46.48±0.36	51.36±0.57	53.09±1.14	53.99±0.94	51.75±0.90	52.42±0.31	50.92±0.55	51.16^{a}±0.42		
	WIN	51.10±0.60	51.59±0.88	49.98±0.37	49.26±0.80	47.23±0.42	47.62±0.88	49.79±0.70	51.21±0.72	49.72^{b}±0.33		
	Zn Mean	49.90^{A}±0.35		49.69^{AB}±0.38		48.91^{B}±0.50		49.67^{AB}±0.37				
CP	PRM	10.05±0.39	9.82±0.27	10.08±0.36	10.24±0.44	10.08±0.15	10.10±0.28	10.06±0.55	10.39±0.25	10.10^{a}±0.12	10.43^{A}±0.11	10.27^{A}±0.13
	MON	12.42±0.19	12.37±0.57	10.90±0.49	9.52±0.26	10.69±0.23	8.36±0.66	9.67±0.34	10.52±0.36	10.56^{b}±0.25		
	PTM	9.64±0.37	9.95±0.28	10.84±0.22	10.46±0.28	10.55±0.24	11.01±0.31	10.83±0.26	10.45±0.21	10.47^{ab}±0.11		
	WIN	11.19±0.41	11.31±0.42	9.92±0.40	10.19±0.28	9.41±0.22	9.28±0.31	10.50±0.26	10.38±0.38	10.27^{ab}±0.16		
	Zn Mean	10.85^{A}±0.21		10.27^{BC}±0.13		9.94^{C}±0.17		10.35^{B}±0.12				
EE	PRM	2.78±0.14	2.36±0.22	3.35±0.21	3.14±0.19	2.07±0.08	2.19±0.10	2.95±0.08	2.39±0.20	2.65^{a}±0.09	2.63^{A}±0.06	2.59^{A}±0.05
	MON	2.71±0.19	2.25±0.14	2.47±0.22	2.44±0.23	2.50±0.15	2.53±0.23	2.87±0.08	2.65±0.17	2.55^{a}±0.06		
	PTM	2.79±0.26	2.92±0.10	2.33±0.13	2.53±0.10	2.77±0.26	2.48±0.21	2.12±0.23	2.76±0.19	2.59^{a}±0.07		
	WIN	3.03±0.22	2.76±0.29	2.35±0.16	2.99±0.23	2.32±0.13	2.43±0.21	2.60±0.18	2.66±0.18	2.64^{a}±0.08		
	Zn Mean	2.70^{A}±0.08		2.70^{A}±0.09		2.41^{B}±0.07		2.63^{A}±0.07				
CF	PRM	7.72±0.26	8.03±0.37	7.94±0.30	7.62±0.37	6.95±0.08	7.31±0.30	6.21±0.42	6.32±0.38	7.26^{a}±0.15	6.70^{A}±0.09	6.43^{B}±0.16
	MON	6.34±0.19	6.91±0.50	6.53±0.19	6.45±0.33	7.30±0.21	6.94±0.21	6.80±0.40	2.45±0.21	6.21^{b}±0.25		
	PTM	6.87±0.28	5.48±0.22	6.01±0.10	7.03±0.41	6.81±0.18	6.24±0.18	6.51±0.24	6.11±0.27	6.39^{b}±0.11		
	WIN	6.54±0.43	6.98±0.29	6.46±0.21	7.10±0.42	5.92±0.19	5.92±0.31	6.28±0.31	5.99±0.27	6.40^{b}±0.12		
	Zn Mean	6.86^{A}±0.16		6.89^{A}±0.14		6.68^{A}±0.11		5.84^{B}±0.23				
Ash	PRM	11.55±0.18	11.11±0.33	10.34±0.31	11.63±0.47	12.09±0.23	11.65±0.39	11.35±0.43	10.85±0.38	11.32^{a}±0.14	10.64^{A}±0.11	10.67^{A}±0.10
	MON	10.97±0.34	10.78±0.37	9.68±0.18	10.07±0.08	10.35±0.30	10.83±0.17	10.43±0.28	9.87±0.14	10.37^{bc}±0.11		
	PTM	9.90±0.17	10.37±0.27	10.38±0.27	10.64±0.56	11.93±0.32	11.15±0.29	10.73±0.34	10.34±0.26	10.68^{b}±0.14		
	WIN	0.26±0.45	10.21±0.30	10.22±0.33	10.44±0.38	9.72±0.22	9.83±0.26	10.10±0.48	10.89±0.38	10.23^{c}±0.13		
	Zn Mean	10.67^{AB}±0.13		10.43^{B}±0.14		10.94^{A}±0.16		10.57^{B}±0.13				
Ca	PRM	1.93±0.07	1.96±0.18	1.49±0.21	0.96±0.05	1.02±0.03	1.30±0.23	1.01±0.11	0.74±0.07	1.30^{a}±0.08	1.05^{A}±0.04	1.07^{A}±0.05
	MON	1.25±0.15	1.77±0.28	0.90±0.09	0.83±0.07	0.85±0.05	0.73±0.11	0.75±0.06	1.03±0.16	1.01^{b}±0.07		
	PTM	0.95±0.06	0.99±0.04	0.90±0.04	0.90±0.08	0.96±0.06	1.04±0.03	0.90±0.05	0.97±0.05	0.95^{b}±0.02		
	WIN	0.91±0.09	0.96±0.07	1.00±0.09	0.99±0.09	0.94±0.06	0.86±0.12	1.00±0.09	1.01±0.13	0.96^{b}±0.03		
	Zn Mean	1.34^{A}±0.08		1.00^{B}±0.05		0.96^{B}±0.04		0.92^{B}±0.04				
P	PRM	0.34±0.03	0.44±0.08	0.31±0.04	0.36±0.03	0.40±0.01	0.37±0.04	0.37±0.05	0.42±0.10	0.38^{a}±0.02	0.39^{A}±0.01	0.42^{A}±0.02
	MON	0.51±0.07	0.61±0.09	0.43±0.06	0.40±0.04	0.37±0.06	0.37±0.03	0.36±0.06	0.34±0.04	0.42^{a}±0.02		
	PTM	0.34±0.04	0.37±0.03	0.40±0.05	0.45±0.05	0.40±0.04	0.41±0.06	0.48±0.07	0.43±0.06	0.41^{a}±0.02		
	WIN	0.44±0.09	0.42±0.05	0.36±0.06	0.39±0.03	0.40±0.04	0.47±0.11	0.40±0.07	0.44±0.07	0.41^{a}±0.02		
	Zn Mean	0.43^{A}±0.02		0.39^{A}±0.02		0.40^{A}±0.02		0.41^{A}±0.02				

Zone Mean and Sex mean with different superscripts between the columns with in a row for each parameters differs significantly (P<0.05)Seasons mean with different superscripts between the rows with in a column for each parameters differs significantly (P<0.05).

than their male counterparts.Theinteractions between season and zone also varied significantly (P<0.05) with regard to grains and by-products, kitchen wastes and green forages. It was also found that the effect of interaction for zone and sex and for season and sex differed significantly (P<0.05) with regard to green forages and kitchen wastes respectively.

Chemical composition of crop contents

Effect of season

The chemical composition of the crop contents is depicted in Table 5. The study revealed that the chemical composition of contents varied with season and location. The results indicated that the mean DM was significantly (P<0.05) higher in PTM season as compared to other seasons. However, the values for DM during PRM and WIN were statistically similar and were higher than MON season. The proportions of CP were significantly (P<0.05) higher during MON season however, the values were comparable with PTM and WIN seasons. There were no significant differences across seasons in regard to ether extract contents. The CF contents were significantly (P<0.05) higher in PRM season as compared to other seasons; however, the values for MON, PTM and WIN seasons were statistically similar. The mean values for ash were higher in PRM season than other seasons. Further, the values recorded during PTM season were comparable with MON season and higher than WIN season. The proportions of Ca were higher in PRM season as compared to other seasons, however the values recorded in MON, PTM and WIN seasons were statistically similar. The P contents did not show any significant differences across seasons.

Effect of location

The proportions of DM in the crop were higher in LBVZ than other zones, however comparable with CBVZ and NBPZ (Table 5). The mean CP recorded in LBVZ was significantly (P<0.05) higher as compared to other zones. Further, levels of CP in CBVZ and NBPZ were comparable to each other and were higher than UBVZ. The ether extract contents in LBVZ, CBVZ and NBPZ were statistically similar but higher than UBVZ. The CF contents did not show significant differences among LBVZ, CBVZ and UBVZ, however the values were higher than NBPZ. The proportions of ash were significantly (P<0.05) higher UBVZ than other zones, however the corresponding values were comparable with LBVZ. The ash contents did not show significant differences CBVZ and NBPZ. The Ca contents were also higher (P<0.05) in LBVZ than other zones, however the values recorded for CBVZ, UBVZ and NBPZ did not differ among them. The total P contents of the crop did not vary significantly across zones.

Effect of sex

The proportions of dry matter, crude protein, ether extract, total ash, calcium and phosphorous in the crop of male chickens did not differ significantly with their female counterparts, however the crude fiber contents in the crop of male chicken were significantly (P<0.05) higher than that of female chicken (Table 5).

Paddy was the primary cereal crop grown across Assam and was normally harvested during post-monsoon season. Hence the chicken under scavenging system could consume left-over grains from paddy field during this season resulted in higher proportion of grains in the crop of chicken. Higher proportions of grains in the crop of chicken might be due to high availability of paddy grains during harvesting season. The present results also corroborated with the findings of other studies (Rashid *et al*., 2005; Momoh *et al*., 2010; Hayat *et al*., 2016; Prakash *et al*., 2020) where it was observed that crop of the scavenging chicken contained higher cereal grains during harvesting season than non-harvesting season. Similarly, Prakash *et al*. (2020) also reported lower proportion of grains during rainy (non-harvesting) season. Contrary to the present results, (Pousga *et al.,* 2005; Ncobela and Chimonyo, 2016) reported comparatively higher per cent of grains during rainy season than the dry season. Higher proportions of kitchen wastes in the crop of scavenged chicken were found during MON (rainy) seasons, as most of the farmers had a tendency to supplement their chicken with kitchen wastes during that lean period. There was also scarcity of scavenged feed resource during MON (non-harvesting) season, as most of the crop fields were sub-merged with water during MON seasons that resultedin scavenged feed resources being unavailable to chicken. Moreover, availability of grains during MON (rainy season) were lower (Prakash *et al.,* 2020) and no crops were harvested during MON seasons; hence scavenged chickens were dependent mostly on kitchen wastes. Similarly, (Rashid *et al*., 2005; Mekonnen *et al*., 2010) also observed higher proportion of kitchen wastes in crop during non-harvestingseason.There were plentiful growth of plants and other vegetations during MON (rainy) season resulted in higher contents of green forages in the crop. The higher proportion of green forages in CBVZ than other zones might be due to abundant growth of plants and vegetation in the said zone as there was higher annual rainfall in CBVZ than other zones (Table 2). Similarly, Momoh *et al.* (2010) also observed higher green forages contents in the crop during early rainy season.The present results also indicated that scavenged chicken consumed higher proportions of insects and worms during MON (rainy) season, as insects and worms were plentiful during rainy season (Goromela *et al*., 2008). The warmer and humid climatic condition provided favorable situation for growth of insects and worms and hence, made them available for scavenged chicken. During winter season most of the insects and worms tend to be hibernated resulted in lower contents of insects and worms in the crop of chicken. The higher occurrence of indigestible miscellaneous particles like sand, grit *etc*. in the crop of scavenged chicken during MON(rainy) season might be attributed to scarcity of scavengeable feed resources such

as cereal grains or others (Goromela *et al*., 2008). Further, most of the crop fields were submerged with rain water during MON season and hence scavenged chicken tend to search feed on public roads resulted in presence of sand, grit and other inert materials in their crop.

The higher percent of DM contents in the crop during PTM (harvesting) season than other seasons might be due to higher intake of paddy grains during said season, as paddy was the primary crop in the study areas. The present DM contents in the crop across seasons and zones corroborated the findings of Rashid *et al.* (2005) and were much lower than (Dessie and Ogle, 2000; Mekonnen *et al.,* 2010). Theintake of DM was also higher in LBVZ than other zones, which might be due to higher annual rainfall that could facilitated more production of other cereal crops. The CP contents were higher during MON (non-harvesting) season as compared to other seasons, which could be due to higher intake of animal protein like insects, worms, maggots, larvae *etc* as they were abundant during non-harvesting seasons (Sonaiya, 2004; Mekonnen *et al*., 2010). However, the CP contentsin different seasons and zones in the study areas were much lower (9.94% to 10.85%) than the (NRC, 1994) recommendation (16% for layer and 14.5% for grower) to maintain optimal growth and production. However, the present CP contents were comparable with the findings of Prakash *et al.* (2020). Thus, the present results indicated that scavenged chickens were deficient in CP in their feed. The higher EE contents in the crop of backyard chicken in LBVZ and CBVZ zones than other zones might be due to higher intake oil seeds like mustard, linseed etc. which were abundantly grown in the said zones. However, the corresponding values recorded across seasons and zones were much lower than the reports of Mekonnen *et al.* (2010). The CF contents across seasons, sexes and zones were much higher than the recommendation of 5% by Feltwel and Fox (1978) could result in poor availability of nutrients. Further, CF contents recorded in PRM season was highest than other seasons, which might be attributed to consumption of undesirable particles like feathers, wood savings *etc*. during that season (Ncobela and Chimonyo, 2016). The ash contents during MON (rainy) and PTM seasons were higher than other seasons. This was attributed to higher consumption of inorganic materials such as soil, sand, stones, grits, egg shells, chicken bones *etc*. during rainy season (Ncobela and Chimonyo, 2016). However, the present values of ash contents in different seasons (10.23 to 11.32%) and zones (10.43 to 10.94%) were comparable with Sheikh *et al*. (2021) and much lower than the reports of (Ncobela and Chimonyo, 2016; Preetam *et al*., 2019). The mean Ca contents of crop were relatively higher in LBVZ zone than other zones. Similarly, it was also higher during PRM season than other seasons. The relatively higher Ca contents in the crop could be attributed to the higher intake of kitchen wastes, which comprised of green vegetables, chicken and fish bones *etc*., were major sources of Ca. The present Ca values across seasons, zones and sexes were comparable with the values obtained in previous studies of Raphulu *et al*. (2015); Afolabi *et al*. (2019) and Prakash *et al*. (2020). The man P contents in crop were more constant (0.38 to 0.43%) and were not affected by seasons, zones and sexes (Raphulu *et al*., 2015). However, both Ca and P contents in the crop of scavenged chicken were relatively much lower while compared with (NRC, 1994). Hence, supplementation of Ca and Pto scavenged chicken could improve the nutritional status, which in turn might augment their productivity (Raphulu *et al*., 2015).

CONCLUSION

From the above study, it may be concluded that nutritional status of free-range scavenging chickens varied with locations and seasons andwere nutritionally deficient in some major nutrients like protein, calcium *etc*. which are the most vital nutrients for their optimal production. Hence, strategic and season and location specific supplemental feeding could be recommended for such chickens to improve their overall productivity, which could in turn benefit the resource poor and economically weaker section of the society.

Conflict of interest

The author (s) declare no potential conflict of interest.

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