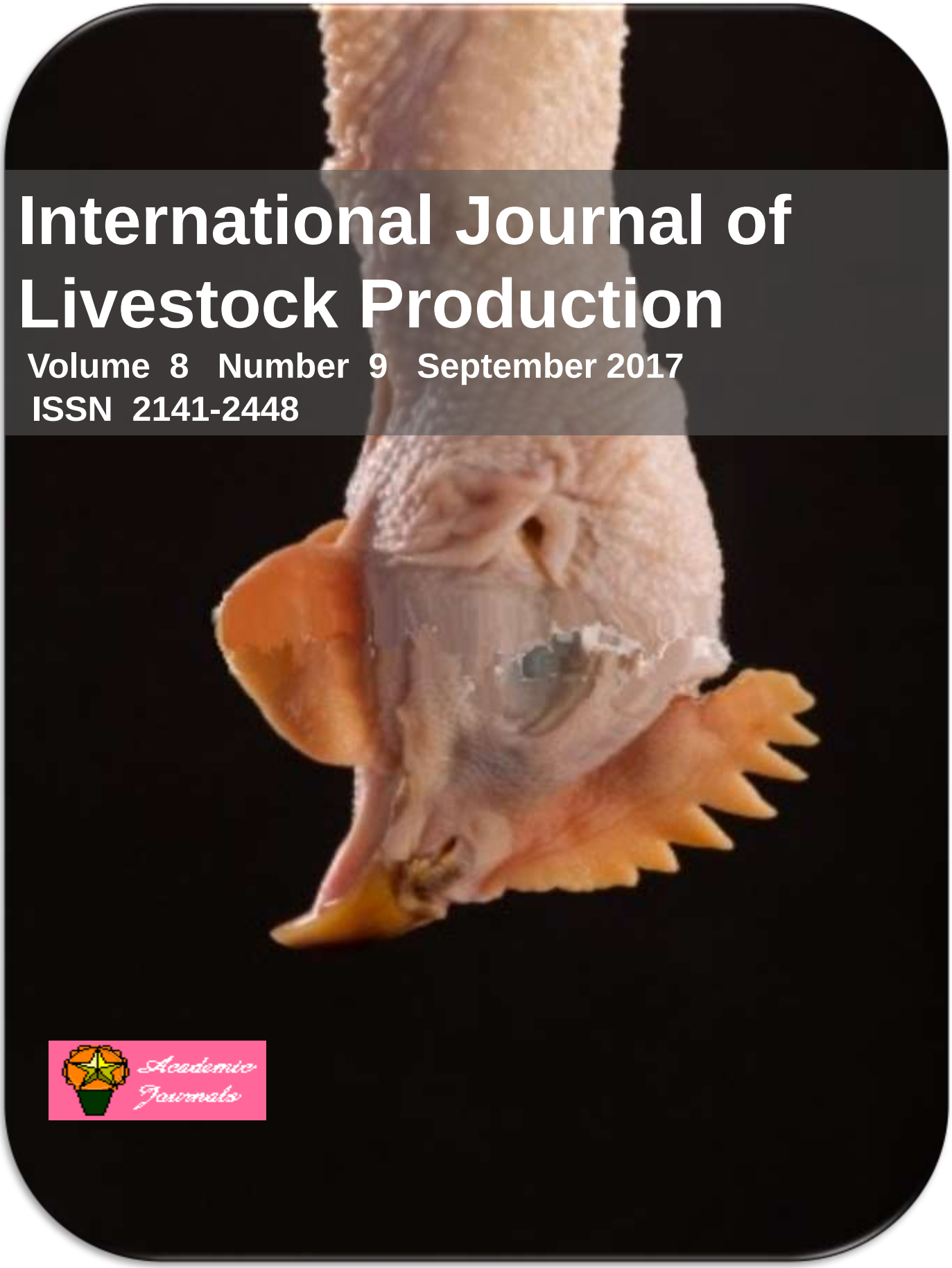

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Table of Contents: Volume 8 Number 9 September 2017

ARTICLES

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Full Length Research Paper

Methionine fortified blood meal can replace fish meal in broiler diets

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This study was conducted to evaluate the growth performance, dressing percent and carcass composition, organ weights and cost-return analysis of broiler chickens fed methionine-fortified blood meal as replacement for fish meal. Two hundred and ten day-old hybro broiler chicks were allotted to 21 floor pens with 10 birds per pen. Seven experimental diets were formulated for starter and finisher phases respectively. Diets 1 (positive control) and 2 (negative control) contained 3% fish meal and 3% blood meal respectively. Diets 3 to 7 contained 3% blood meal each with 0.1, 0.2, 0.3, 0.4 and 0.5% methionine fortifications, respectively. Each diet was fed as mash to birds in 3 pens in completely randomized design. Results of growth performance showed no significant ($p>0.05$) differences in average daily feed intake, average daily weight gain and feed conversion ratio but mortality revealed significant ($p<0.05$) difference. Final body weight and dressing percentage were not affected by the treatment ($p>0.05$). Significant ($p<0.05$) differences were observed in the moisture, crude protein, ether extract, ash and nitrogen free extract contents for breast and thigh muscles. Cost-return analysis revealed significant ($p<0.05$) differences in total variable cost, total revenue, gross margin and returns on investment. In conclusion, 3% blood meal with up to 0.5% methionine fortification can favourably replace 3% fish meal as an animal protein source for broilers.

Key words: Methionine-fortified blood meal, fish meal, growth performance, carcass characteristics, broilers.

INTRODUCTION

The competition between man and poultry for feed is partly fuelled by the insufficient production of edible crops to meet the needs of man and his livestock (Babatunde et al., 1990; Esonu et al., 2001) and the threat of desert encroachment in numerous segments of the West Africa which has destroyed vegetation (Idufueko, 1984;

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Madubuike, 1992). Poultry nutritionists are consequently faced with the responsibility of finding unconventional feedstuffs that will not compromise quality.

Animal protein sources have a good balance of essential amino acids but are expensive. Fish meal is an expensive animal protein concentrate and usually ranks highest in cost among animal protein concentrates in feed formulation. Consequently, an incessant effort exists in the replacement of fish meal with cheaper and unconventional animal protein sources in the diets of poultry (Dafwang et al., 1986; Udedibie et al., 1988; Fanimo et al., 1988; Dongmo et al., 2000).

Bovine blood is a slaughter by-product which poses serious disposal problem in most slaughter houses (Onyimonyi and Ugwu, 2007). Blood meal from cattle contains about 80% crude protein (Ewane, 1996), and the protein has a very high biological value for poultry compared with vegetable protein (Memon et al., 2002). Blood meal protein is the richest source of natural lysine (Odukwe and Njoku, 1987). It is best considered as the feed ingredient for increasing lysine levels in diets (Donald et al., 1988). The low digestibility, low methionine content (Schingoethe, 1991) and distinctive smell of blood meal however, limit its use in poultry rations. Blood meal has been recommended at 5% in the diet (Seifdavati et al., 2008).

Methionine is an essential amino acid required by poultry (Itoe et al., 2010). Vegetable protein concentrates which are increasingly being used in poultry rations are mostly deficient in methionine thus the need for supplementing this amino acid. North and Bell (1990) revealed that it may be more cost-effective to supplement diet with methionine than to add more of soybean or other proteins to meet the requirement. Supplementation of low protein diets with amino acids for the various classes of poultry has been studied (Zeweil et al., 2011). Therefore, the objective of this research was to evaluate methionine-fortified blood meal as replacement for fish meal in poultry broiler diets. .

MATERIALS AND METHODS

Location of the study

The study was carried out at the Poultry Unit of the Department of Animal Science, Faculty of Agriculture Teaching and Research Farm, University of Calabar, Nigeria.

Collection and preparation of blood meal and fish meal

Bovine blood was collected from the Abattoir in Akim Army Barracks in Calabar immediately after slaughter. The blood was boiled at 100°C for 40 min, cut into smaller pieces and sun-dried for 72 h. The sun-dried blood was milled using hammer mill to pass through 0.2 mm sieve and stored in bags in a cool dry place. Whole and shredded dry bonga fish (*Ethmalosa fimbriata*) were purchased from the Beach market in Calabar and ground into meal using the hammer mill to pass through 0.2mm sieve and stored in bags in a cool dry place. Blood meal and fish meal were analyzed for proximate composition and amino acid profile and used for the formulation.

Experimental diets

Seven (7) diets were formulated for the broiler starter (Table 1) and finisher (Table 2) phases. Diets 1 (positive control) and 2 (negative control) contained 3% fish meal and 3% blood meal respectively without added methionine. Diets 3 to 7 contained 3% blood meal each with 0.1, 0.2, 0.3, 0.4 and 0.5% methionine fortifications respectively. The diets were analyzed for their proximate (AOAC, 1990) and amino acid compositions (Spackman et al., 1958).The results of the proximate and amino acid compositions of blood meal and fish meal (Table 3) guided the formulation of the experimental diets.

Experimental birds and management

Two hundred and ten day-old hybro broiler chicks, purchased from a reputable distributor in Calabar were used for this experiment. The chicks were weighed and randomly allotted 21 floor pens of similar body weights. Each diet was fed as mash to 3 replicate pens of 10 birds each in a completely randomized design. Vaccination schedule for broilers was strictly adhered to. The study lasted for 9 weeks.

Parameters measured

Weight gain was obtained weekly and divided by seven to obtain daily weight gain. Daily feed intake was obtained by deducting the weight of left over feed from that given. Feed conversion ratio was calculated by dividing the cumulative values of daily feed intake by daily weight gain. Mortality was properly monitored and recorded. To evaluate carcass, three (3) birds per replicate (9 birds per treatment) were selected randomly and fasted for 12 h in preparation for slaughter. The birds were slaughtered by severing the jugular vein. After slaughter, birds were bled, dipped in hot water at 100°C for 60 s and defeathered by hand-plucking. The shanks and viscera were removed for the determination of dressed weight and dressing percentages. The weights of cut up parts and internal organs were expressed as percentages of dressed weight. Intestinal length was measured in centimetres (cm). After slaughter and carcass evaluation, bones of breast and thigh were separated from muscle and connective tissues. Deboned samples were analyzed in the laboratory chemically for their proximate composition according to AOAC (1990). For cost-return analysis, the values for total variable cost and total revenue were computed and gross margin was calculated by deducting total variable cost from total revenue. Returns on investment were obtained by dividing the gross margin by total variable cost (Jhingan, 1997).

Chemical analyses of blood meal and fish meal

Samples of processed blood meal and fish meal were analyzed for their proximate (AOAC, 1990) and amino acid (Spackman et al., 1958) compositions. For amino acid analysis samples of blood meal and fish meal were dried to constant weights, defatted, hydrolyzed and evaporated in a rotary evaporator and then loaded into the Technicon Sequential Multisample amino acid analyzer (TSM).

Statistical analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) for CRD using Data Analysis Tool in Microsoft Excel 2010 and treatment means compared using Duncan Multiple Range Test

Table 1. Ingredient composition of experimental diet for broiler starter phase.

	Methionine fortified blood meal diets						
Ingredients (kg)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**
Maize	54.02	54.02	54.02	54.02	54.02	54.02	54.02
Soybean meal	31.48	31.98	31.88	31.78	31.68	31.58	31.48
Fish meal	3.00	0.00	0.00	0.00	0.00	0.00	0.00
Blood meal	0.00	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Palm kernel cake	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Vitamin premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Lysine	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Methionine	0.00	0.00	0.10	0.20	0.30	0.40	0.50
Calculated composition							
ME (Kcal/kg)	2896.64	2919.14	2916.44	2913.74	2911.00	2908.34	2905.64
Lysine (%)	1.12	1.04	1.03	1.03	1.02	1.02	1.02
Methionine (%)	0.56	0.54	0.62	0.63	0.64	0.65	0.67
Analyzed composition							
Crude protein	22.78	23.11	23.04	23.10	23.12	23.08	23.01
Crude fibre	4.93	4.99	4.96	4.95	4.95	4.92	4.92
Ether extract	3.87	3.62	3.63	3.62	3.62	3.63	3.65
Calcium	1.94	1.93	1.92	1.92	1.92	1.92	1.90
Phosphorus	0.60	0.59	0.60	0.61	0.61	0.61	0.61
Ash	5.06	5.13	5.12	5.15	5.10	5.17	5.18
NFE	63.35	63.16	63.26	63.18	63.21	63.20	63.25

Each Kg feed contained (Optimix premix): Vitamin A 10,000000I.U.; Vitamin D3 2,00000 I.U.; Vitamin E 20,000I.U.; Vitamin 500 mg; K 2250 mg; Thiamine 1750 mg; Riboflavin B2 5000 mg; Pyridoxine B6 2,750; antioxidant 125 g; Niacin 27,500 mg; Vitamin B12 15 mg; Pantothenic acids 7,500 mg; Biotin 20 mh; Choline Chloride 400 g, Manganese 80 g; Zinc 50 g; Iron 20 g; Copper 5 g; Iodine 1.2 g; Selenium 200 mg; Cobalt 200 mg

Table 2. Ingredient composition of experimental diet for broiler finisher phase.

	Methionine fortified blood meal diets						
Ingredients (Kg)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**
Maize	56.50	56.50	56.50	56.50	56.50	56.50	56.50
Soybean meal	28.50	29.00	28.90	28.80	28.70	28.60	28.50
Fish meal	3.00	0.00	0.00	0.00	0.00	0.00	0.00
Blood meal	0.00	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offal	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Palm kernel cake	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Palm oil	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Vitamin premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Lysine	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Methionine	0.00	0.00	0.10	0.20	0.30	0.40	0.50
Calculated composition							
ME (Kcal/kg)	2980.50	3003.00	3000.30	2997.60	2994.90	2992.20	2926.50
Lysine (%)	1.08	1.01	1.01	1.00	1.00	1.00	1.00
Methionine (%)	0.44	0.42	0.46	0.48	0.49	0.51	0.52
Analyzed composition							
Crude protein	19.58	20.82	20.72	20.52	20.36	20.19	20.02

Table 2. Contd.

Crude fibre	5.00	5.01	5.01	5.02	5.03	5.03	5.02
Ether extract	3.85	3.60	3.61	3.62	3.62	3.64	3.64
Calcium	1.85	1.83	1.83	1.82	1.82	1.82	1.81
Phosphorus	0.52	0.50	0.55	0.54	0.54	0.54	0.54
Ash	5.05	5.13	5.15	5.15	5.13	5.16	5.16
NFE	66.52	65.44	65.51	65.69	65.86	65.98	66.10

Each Kg feed contained (Optimix premix): Vitamin A 8,000000 I.U.; Vitamin D3 1,600000 I.U.; Vitamin E 5,000 I.U.; Vitamin K 2000 mg; Thiamine 1500 mg; Riboflavin B2 4,000 mg; Pyridoxine B6 1500 mg; antioxidant 125 g; Niacin 1,500 mg; Vitamin B12 10 mg; Panthotenic acids 5,000 mg; Folic acid 500 mg; Biotin 20 mg; Choline Chloride 200 g, Manganese 80 g; Zinc 50 g; Iron 20 g; Copper 5 g; Iodine 1.2 g; Selenium 200 mg;Cobalt 200 mg.

Table 3. Proximate composition and amino acid profile of blood meal and fish meal (dry matter basis).

Parameter (%)	Blood meal	Fish meal
Crude protein	83.12	65.43
Ether extract	1.00	12.95
Ash	5.00	13.38
NFE	10.88	8.24
Amino acids (g/100 g)		
Methionine	0.90	2.20
Cysteine	1.40	2.00
Lysine	9.00	5.20
Tryptophan	1.00	1.70
Isoleucine	0.75	2.50
Histidine	3.05	4.29
Valine	5.15	5.89
Leucine	10.30	6.86
Arginine	2.22	4.67
Glycine	4.60	5.00
Threonine	4.80	5.50
Phenylalanine	6.00	6.50
Tyrosine	3.30	3.50

(DMRT). Differences were considered significant at 5% probability.

RESULTS

Table 4 shows the results of the effect of blood meal with methionine fortification on growth performance of broilers. No significant ($p>0.05$) differences were observed in feed intake, weight gain and feed conversion ratio. There was significant ($p<0.05$) difference in mortality. The percentage mortality ranged between 3.33 and 10%. The result of carcass and internal organ characteristics (Tables 5 and 6) showed that there were no significant ($p>0.05$) differences in live weight, dressed weight, dressing percentage, and percent heart, liver, lungs, kidney, gizzard, proventriculus and gall bladder. However, there were significant differences in mean weights of breast (18.31 to 19.30%), thigh (20.33 to 22.71%), crop (0.50 to 0.68%), abdominal fat (0.95 to 1.57%) and intestinal length (187.40 to 244.41 cm). Table 7 shows the results of proximate composition for the breast and thigh muscles. Significant ($p<0.05$) differences were observed in moisture content (66.64 to 73.37%; 62.77 to 72.50%), crude protein (25.63 to 32.03%; 22.14 to 29.32%), ether extract (0.54 to 1.17; 2.83 to 5.77%), ash (0.14 to 0.63; 0.41 to 1.28%) and nitrogen free extract values (0.05 to 0.25; 0.25 to 1.02%) for the breast and the thigh muscles among treatments. The result of cost-return analysis (Table 8) showed significant ($p<0.05$) differences in total variable cost (₦952.81 to ₦1088.97), total revenue (₦1350.00 to ₦1600.00), gross margin (393.94 to 597.19) and return on investment (0.41 to 0.63).

DISCUSSION

Growth performance

The values for feed intake, weight gain and feed

Table 4. Growth performance of broilers fed methionine-fortified blood meal.

Parameters (g)	Treatments							
	Positive control	Negative control	0.1%	0.2%	0.3%	0.4%	0.5%	SEM
Initial body weight (g/bird)	47.00	44.00	43.00	43.00	44.00	45.00	45.00	0.53
Final body weight (g/bird)	1910.00	1700.00	1800.00	1910.00	1920.00	1925.00	1927.00	25.47
Av. Daily weight gain(g/bird/day)	29.57	26.28	27.89	29.63	29.78	29.84	29.89	6.96
Av. Daily feed intake (g/bird/day)	98.25	94.44	100.00	103.02	90.32	95.87	102.22	17.58
Feed conversion ratio	3.45	3.49	3.65	3.36	2.89	3.41	3.77	0.54
Mortality (%)	3.33^{c}	3.33^{c}	3.33^{c}	3.33^{c}	6.66^{b}	10.00^{a}	10.00^{a}	0.69

Means with different superscripts within the same row are significantly ($p<0.05$) different; SEM, standard error of mean.

Table 5. Carcass characteristics and cut up parts of broilers fed methionine-fortified blood meal.

Parameter	Treatments							
	Positive control	Negative control	0.1%	0.2%	0.3%	0.4%	0.5%	SEM
Live weight (g)	1910.00	1700.00	1800.00	1910.00	1920.00	1925.00	1927.00	25.47
Dressed weight(g)	1846.67	1626.67	1727.33	1837.00	1847.00	1850.00	1855.00	33.25
Dressing %	96.68	95.69	95.96	96.18	96.20	96.10	96.26	4.91
Breast (%)	18.31^{d}	18.37^{d}	19.30^{a}	18.61^{c}	18.77^{c}	19.06^{b}	19.26^{a}	0.22
Thigh (%)	20.33^{f}	20.40^{e}	21.53^{c}	21.35^{d}	21.54^{c}	21.91^{b}	22.71^{a}	0.24

Means with different superscripts within the same row are significantly ($p<0.05$) different; SEM, standard error of mean.

Table 6. Internal organ characteristics of broilers fed methionine-fortified blood meal.

Parameter (%)	Treatments							SEM
	Positive control	Negative control	0.1%	0.2%	0.3%	0.4%	0.5%	
Heart	0.64	0.57	0.54	0.61	0.53	0.46	0.73	0.05
Liver	2.59	2.76	3.28	2.87	3.03	3.16	3.42	0.28
Lungs	0.65	0.74	0.72	0.64	0.61	0.53	2.59	0.10
Kidney	0.12	0.13	0.23	0.13	0.13	0.15	0.15	0.03
Gizzard	4.16	3.93	4.14	3.92	4.14	3.79	4.37	0.48
Proventriculus	0.62	0.63	0.63	0.58	0.55	0.56	0.66	0.08
Gall bladder	0.16	0.17	0.18	0.20	0.14	0.08	0.20	0.10
Crop	0.51^{e}	0.52^{e}	0.68^{a}	0.65^{b}	0.61^{c}	0.50^{d}	0.67^{a}	0.05
Abdominal fat	1.37^{b}	0.95^{f}	1.57^{a}	1.37^{c}	1.14^{d}	1.41^{b}	1.41^{b}	0.05
Intestinal length (cm)	244.41^{a}	189.10^{f}	239.00^{b}	199.40^{e}	200.60^{d}	187.40^{f}	225.80^{c}	5.18

Means with different superscripts within the same row are significantly ($p<0.05$) different; SEM, standard error of mean.

conversion ratio on the methionine fortified diets were comparable with the positive control (based on fish meal).The values were statistically similar and showed that up to 0.5% methionine fortification in blood meal did not have any adverse effect on growth performance.

The broilers whose diets was fortified with 0.2% methionine tended to have consumed more feed (103.02 g) followed by 0.5% (102.22 g), 0.1% (100.00 g), positive control (98.25 g), 0.4% (95.87 g), negative control (94.44 g) and 0.3% (90.32 g).The absence of significant difference in feed intake may be caused by the similarity of the metabolizable energy concentration of the diets since birds eat to satisfy their energy requirements (Onu et al., 2010). Absence of significance agrees with the works of the following authors: Kalbande et al. (2009) who supplemented diets of broilers with different levels of methionine; Bouyeh (2012) who tested excess lysine and methionine on the immune system and performance of

Table 7. Proximate composition of the breast and thigh muscles of broilers fed methionine-fortified blood meal (dry matter basis).

	Treatments							
Parameter (%)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**	**SEM**
Breast								
Crude protein	27.35^{b}	30.26^{a}	32.03^{a}	31.53^{a}	25.63^{c}	25.74^{c}	26.76^{b}	0.59
Ether extract	0.57^{d}	0.79^{b}	0.67^{c}	1.17^{a}	0.67^{c}	0.54^{d}	0.55^{d}	0.03
Ash	0.28^{d}	0.63^{a}	0.33^{c}	0.50^{b}	0.26^{d}	0.27^{d}	0.14^{e}	0.03
NFE	0.22^{a}	0.05^{c}	0.25^{a}	0.16^{b}	0.07^{c}	0.23^{a}	0.14^{b}	0.03
Moisture	71.58^{ab}	68.27^{b}	66.72^{b}	66.64^{b}	73.37^{a}	73.27^{a}	72.41^{ab}	0.66
Thigh								
Crude protein	22.14^{c}	27.68^{ab}	25.32^{b}	26.85^{ab}	25.14^{b}	29.32^{a}	26.03^{ab}	0.49
Ether extract	4.26^{c}	2.83^{e}	4.77^{b}	4.57^{b}	4.63^{b}	5.77^{a}	3.29^{d}	0.50
Ash	0.69^{c}	0.63^{c}	1.00^{b}	0.98^{b}	1.28^{a}	1.12^{a}	0.41^{d}	0.05
NFE	0.41^{c}	0.31^{c}	0.71^{b}	0.25^{d}	0.88^{a}	1.02^{a}	0.27^{d}	0.05
Moisture	72.50^{a}	68.55^{ab}	68.20^{ab}	67.35^{ab}	68.07^{ab}	62.77^{c}	70.00^{a}	0.72

Means with different superscripts within the same row are significantly ($p<0.05$) different.

Table 8. Cost-return analysis of broilers fed methionine-fortified blood meal.

	Treatments							
Cost (₦)	**Positive control**	**Negative control**	**0.1%**	**0.2%**	**0.3%**	**0.4%**	**0.5%**	**SEM**
Day-old cost	170.00	170.00	170.00	170.00	170.00	170.00	170.00	
Feed cost	742.49	609.58	654.19	679.57	606.33	651.90	703.89	
Vaccine	7.62	7.62	7.62	7.62	7.62	7.62	7.62	
Medication	16.43	16.43	16.43	16.43	16.43	16.43	16.43	
Litter material	10.71	10.71	10.71	10.71	10.71	10.71	10.71	
Miscellaneous	141.72	141.72	141.72	141.72	141.72	141.72	141.72	
Total variable cost	1088.97^{a}	956.06^{f}	1000.67^{d}	1026.05^{c}	952.81^{f}	998.38^{e}	1050.37^{b}	10.72
Av. Income/bird	1400.00	1200.00	1300.00	1350.00	1400.00	1400.00	1450.00	
Sale of manure/bag	150.00	150.00	150.00	150.00	150.00	150.00	150.00	
Total revenue	1550.00^{b}	1350.00^{e}	1450.00^{d}	1500.00^{c}	1550.00^{b}	1550.00^{b}	1600.00^{a}	18.26
Gross margin	461.03^{c}	393.94^{e}	449.33^{d}	473.95^{c}	597.19^{a}	551.62^{b}	549.63^{b}	15.54
ROI	0.42^{e}	0.41^{e}	0.45^{d}	0.46^{d}	0.63^{a}	0.55^{b}	0.52^{c}	0.02

Means with different superscripts within the same row are significantly ($p<0.05$) different; ROI, returns on investment.

broilers; Kaur et al. (2013) where performance of commercial broilers were compared after replacing Herbomethione® with DLmethionine in their diets; Egenuka et al. (2015) where increasing level of dietary level of blood meal and reduced supplementary lysine were tested on performance of broilers and Ahmed and Abass (2015) who evaluated the broiler performance and carcass characteristics when herbal methionine versus dl-methionine were supplemented in broiler diets.

Broilers fed diets containing 0.5% methionine fortifications seemed to have higher daily weight gain values (29.89 g), followed by 0.4% (29.84 g), 0.3% (29.78 g), 0.2% (29.63 g), positive control (29.57 g), 0.1% (27.89 g) and negative control (26.28 g). The values tended to increase non-significantly as methionine fortifications increased across treatments. This confirms that methionine aids broilers to meet up with body tissue deposition that is a pre-requisite for rapid growth. Absence of significant difference in daily weight gain is in line with the works of Kaur et al. (2013), Egenuka et al. (2015) and Ahmed and Abass (2015).

In order of improvement, feed conversion ratio was best in 0.3% methionine fortification (2.89), followed by 0.2% (3.36), 0.4% (3.41), positive control (3.45), negative control (3.49), 0.1% (3.65) and 0.5% (3.77). The feed conversion for non-ruminants is influenced by the concentrations of methionine and lysine in the diet (Onu et al., 2010). Statistically similar values observed across treatments may be attributable to a more balanced combination of methionine and lysine in broiler diets.

Absence of significant difference in feed conversion ratio is in line with the works of Kaur et al. (2013), Egenuka et al. (2015) and Ahmed and Abass (2015).

Significantly higher mortalities observed in 0.4 and 0.5% methionine fortifications were consistent with the findings of Khawaja et al. (2007) when 3% blood meal was included in broiler diets than when 0, 4, 5 and 6% blood meal were included in their diets. The authors suggested that this was due to ascites occurring because of fast growth, high feed conversion and bulky pectoral muscle mass which all require high level of oxygen.

Carcass characteristics

Live weight and dressing weight were highest for 0.5% methionine fortification (1927.00 and 1855.00 g, respectively) and lowest for the negative control (1700.00 and 1626.67 g, respectively). The values increased non-significantly as methionine fortifications increased across treatments; confirming the role of methionine in aiding broilers meet up with body tissue deposition which is a pre-requisite for rapid growth. Absence of significant difference was supported by the findings of El-shinnawy (2015) who supplemented betaine in methionine adequate diet of broilers. It also aligns with the work of Poosuwan et al. (2015) who evaluated the effects of varying levels of liquid DL-methionine hydroxyl analog free acid in drinking water on production performance and gastrointestinal tract of broiler chickens at 42 days of age. Dressing percentages were comparable with the highest percentage recorded for the positive control (96.68%) and lowest for negative control (95.69%).

Breast meat yield was highest for 0.1% methionine fortification (19.30%) and lowest for the positive control (18.31%). Breast meat yield constitutes a major portion of protein synthesis and is sensitive to amino acid status in diets (Jialin et al., 2004). This sensitivity may have contributed to the variations in the breast yield. The observed significant increase in breast muscles was supported by the reports of Bouyeh (2012) and Ebrahimzadeh et al. (2013) who checked the effects of chromium methionine supplementation on performance, carcass traits, and the Ca and P metabolism of broiler chickens under heat-stress conditions and El-shinnawy (2015).

Thigh yield was highest in 0.5% methionine fortification (22.71%) and lowest for the positive control (20.33%). The values tended to increase as methionine fortifications increased from 0.2 to 0.5%. Significant increase in weight of thigh muscles may also be associated with the function of methionine in creatine synthesis (Hesabi et al., 2006). Significant differences for thigh muscles align with the findings of Ebrahimzadeh et al. (2013) and Poosuwan et al. (2015).

Significant difference in the crop weight may have been affected by the quantity of feed retained in the crop and was highest in 0.1% methionine fortification. Values of intestinal length for 0.1 and 0.5% were comparable with the positive control which was the highest. This indicated that their capacity to extract and maximize nutrients from the diets (Sibley, 1981) was high compared to others. Absence of significant differences in the weight of liver agreed with the findings of the following authors: Memon et al. (2002) when effect of blood meal on the growth and carcass yield of broilers were studied; Khawaja et al. (2007) and Nasr and Kheiri (2012) who investigated the effects of lysine levels of diets formulated based on total or digestible amino acids on broiler carcass composition; Ebrahimzadeh et al. (2013), El-shinnawy (2015) and Ndelekwute et al. (2016) who combined fish meal and blood meal at different proportions and checked for broilers' response in terms of carcass yield and internal organs. Absence of significant differences in the weight of heart and gizzard agreed with the findings of Memon et al. (2002) and Khawaja et al. (2007). Broilers in negative control had significantly lower abdominal fat than other treatments suggesting that the absence of methionine fortification in a diet might cause a decrease in abdominal fat deposition. Significant differences in abdominal fat is in line with the reports of Andi (2012) who undertook a study to investigate the effect of additional DL-methionine in starter diet of broilers abdominal fat and Bouyeh, 2012; Ebrahimzadeh et al., 2013; El-shinnawy, 2015.

Proximate composition

Crude protein content of breast muscles was higher than those of the thigh muscles among treatments except in 0.4% methionine fortification. This may suggest that methionine fortification of 0.1 to 0.3 and 0.5% significantly influenced a higher retention of crude protein in the white meat (breast muscle) than in dark meat (thigh muscle). This agrees with report of Jialin et al. (2004) that breast meat represents a major portion of protein synthesis and is sensitive to amino acid status in diets. Significant difference observed in crude protein of thigh muscles agreed with the result of El-shinnawy (2015) who supplemented betaine in methionine adequate diet of broilers and observed significant differences in crude protein value of thigh muscles. On the other hand, ether extract, ash and nitrogen free extract for thigh muscles were higher in thigh muscles than breast muscles among treatments. This may also suggest that methionine supplementation significantly influenced a higher retention of fats, minerals and carbohydrates in the thigh muscle than breast muscle. Moisture content seemed to be similar in range. Significant differences observed in parameters measured among treatments for both breast and thigh muscles may have been caused by differences in proximate composition of feeds. Snežana et al. (2010) noted that nutrition has a significant influence on the proximate composition of broiler meat. Nutritional factors

that affect chemical composition and quality of broiler meat are: Choice of feed ingredients for feed formulation, chemical composition of feed ingredients and energy and protein values of formulated rations (Snežana et al., 2010).

Cost-return analysis

Total variable costs of production for negative control up to 0.5% methionine fortifications were lower than positive control. This implies that cost of production using fish meal as an animal protein source was higher than using blood meal with or without methionine fortification. The highest gross margin observed in 0.3% implies maximum profitability when broilers were raised on diets containing 3% dietary blood meal inclusion with 0.3% methionine fortification. The highest return on investment (ROI) observed in 0.3% indicates better returns on naira invested and confirms maximum profitability. The result is consistent with the findings of Memon et al. (2002) who supplemented four different levels of blood meal in broiler diet and concluded that broilers could be reared economically by using 3% of blood meal as an animal protein source and Khawaja et al. (2007) who supplemented four different levels of blood meal in broiler diet and discovered that it is more feasible and economical to obtain maximum profitability from broiler production when 3% level of blood meal was included in their diets..

Conclusion

From the results it can be concluded that fortification of blood meal with methionine will reduce cost of production without adverse effects on broiler performance compared to a fish meal-based control. Maximum profitability was achieved when 0.3% methionine fortified 3% blood meal.

CONFLICTS OF INTERESTS

The authors have not declared any conflict of interests.

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Production performance of Sasso (distributed by ethio-chicken private poultry farms) and Bovans brown chickens breed under village production system in three agro-ecologies of Southern Nations, Nationalities, and Peoples' Regional State (SNNPR), Ethiopia

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A quick survey study was conducted with the objectives of assessing farmers trait preference and productive performance of Sasso provided by Ethio-chicken private poultry farms under village production system in three agro ecologies of SNNPR, Ethiopia. Totally, 135 randomly selected respondents (45 from each agro ecologies) were included in the study. The data collected were analyzed using descriptive statistics and one way ANOVA. According to the respondents most of the farmers were currently rearing more Sasso breeds in all agro ecologies (40.4, 72.7 and 47.7 in highland, midland and lowland respectively) than Bovans brown (17, 6.8 and 20.5% in highland, midland and lowland respectively). Current study exposed that 94.4% of respondents on average in all agro ecologies select Bovans brown for egg production while Sasso breed was selected by respondents (97.7%) for having large body size and producing high amount of meat. The information collected on age at first laying disclosed that the mean ages at first laying were 5.9±1.5, 5.7±1, and 7.1± 1.6 months for Sasso, Bovans brown and local breeds respectively. The result in the current study revealed that the average egg production per month of Bovans brown (22.2) is higher than that of Sasso (16.2) and local chickens (12.6). Most respondents repeatedly mentioned feed shortage as the first ranked chicken production constraint in all districts (25.4%) whereas predators (20.1%) were the second and disease was the third problem in overall agro ecologies though there were significant ($p<0.05$) differences among agro ecologies. To have a clear understanding of the performance of Sasso breeds of ethio-chicken private farms, on-farm and on-station controlled experiment on management practices and feeding strategy is important.

Key words: Sasso, agro ecologies, productive performances, trait preference.

INTRODUCTION

Poultry production has an important economic, social and cultural benefit and plays a significant role in family nutrition in the developing countries. The proportional contribution of poultry to the total animal protein production of the world by the year 2020 is believed to increase to 40%, the major increase being in the developing world (Delgado et al., 1999). It has been estimated that 80% of the poultry population in Africa is found in traditional scavenging systems (Gueye, 2000). In most tropical countries it is based mainly on scavenging production systems, which makes substantial contributions to household food security throughout the developing world (Muchadeyi et al., 2007). Indigenous breeds still contribute meaningfully to poultry meat and egg production and consumption in developing countries, where they make up to 90% of the total poultry population. All over the developing world, these low-input, low output poultry-husbandry systems are an integral component of the livelihoods of most of rural, peri-urban, and some urban households and are likely to continue to meet this role for the foreseeable future (Besbes, 2009). Livestock production covers 40% of agricultural output in Ethiopia, playing an important role in the national economy as it contributes 18% of the total GDP (FAO, 2010). A Central Statistics Agency CSA (2015) report revealed that 95.86% of the total poultry population comprises indigenous birds, while 2.79 hybrids and 1.35% are exotic breeds. The poultry sector in Ethiopia can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feed, health, technology, and bio-security. These are large commercial, small scale commercial and village or backyard poultry production system. These production systems have their own specific chicken breeds, inputs and production properties. Each can sustainably coexist and contribute to solve the socio-economic problems of different target societies (Tadelle et al., 2003a).

The backyard (traditional) poultry production system is characterized by low input, low output and periodic destruction of large proportion of the flock due to disease outbreaks (Tadelle et al., 2003b). With the aim of improving poultry productivity, different breeds of exotic chickens (Rhode Island Red, Australorp, New Hampshire and White Leghorns) were imported to Ethiopia since the 1950"s. Since then higher learning institutions, research organizations, the Ministry of Agriculture and Non-Governmental Organizations (NGO"s) have disseminated many exotic breeds of chicken to rural farmers and urban-based small-scale poultry producers (Solomon, 2008). There has been a substantial effort to introduce improved hybrid layer chickens particularly Isa Brown (IB), Bovan Brown (BB) and dual purpose hybrid Potchefstroom Koekoek (PK) to smallholder farmers under backyard management in the study region.

However, lack of recorded data on the performance of chicken and all aspects of management, lack of regular chicken health program and market information makes it difficult to assess the importance and contributions of the past attempts to improve the sector (Moges et al., 2010). In addition, most of the exotic breeds studied under village production system are not high yielding hybrids type used in the international poultry industry (FAO, 2010). Consequently, there is a need to define the present performance of high yielding layers such as IB, BB and dual-purpose hybrids in selected areas of SNNPR. As a result, systematic study was required to assess management practices used and determine productive performances of improved poultry chicken mainly Sasso breed under village production system. Thus, the present study was conducted in selected districts of the region with the following objectives:

1. To determine the production and productivity performances of Sasso and Bovans brown chickens under village production system.
2. To determine farmers' preferences/perception for different chicken breeds and their products.
3. To identify opportunities and constraints of chicken production in different agro-ecologies in the study areas.

METHODOLOGY

The study was conducted at Sidama, Wolaita, Kambata Tambaro, Silte and Gamo gofa zones in the SNNPR.. Selection of study area and households was done through selecting two different woedas and agro-ecologies in each zones purposively based on the extent and intensity of improved chicken distribution and participating in improved poultry extension package at least in the last one and more years. The list of households, which have adopted improved chickens specially Sasso and Bovans brown from each PAs, has been used as sampling frame. A total of ten woreda in each zone were selected. The selected Woredas were classified in three agro-ecologies (highland, midland and lowlands). From each of the selected agro ecologies, 45 households were purposively selected. Accordingly, a total of 135 (45 households × 3 agro-ecologies) households were used in the survey. Finally, questionnaire survey has started after it has been edited or tested with different stakeholders assigned from Bureau of Livestock and Fishery Resource and poultry researchers from Southern Agricultural Research Institute.

Across sectional survey also carried out for each household to collect information focusing on status of keeping improved chicks, use of extension packages and its constraints from member(s) of

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Table 1. Types of breeds farmers currently rearing and Source of breeds in study areas (%).

Breeds	Agro-ecological zone			Total (N=135)	X^2
	Highland (N=47)	Midland (N=44)	Lowland (N=44)		
Breeds rearing					
Sasso	40.4	72.7	47.7	53.3	14.94
BB	17.0	6.8	20.5	14.8	
Sasso and BB	17.0	9.1	6.8	11.1	
Sasso and Local	21.3	9.1	22.7	17.8	
Sasso, BB and Local	2.1	2.3	0.0	1.5	
BB and local	2.1	0.0	2.3	1.5	
Source of improved breeds					
Extension	48.9	79.5	61.4	63.0	44.39***
NGO	17.0	0.0	9.1	8.9	
Purchased from market	8.5	9.1	4.5	7.4	
Purchased from government farm	21.3	0.0	2.3	8.1	
Purchased from private poultry farm	2.1	0.0	6.8	3.0	
Government extension agents and purchased from market	2.1	11.4	4.5	5.9	
Purchased from cooperatives	0.0	0.0	11.4	3.7	
Preferred breeds (%)					
Bovans Brown	44.7	68.2	50.0	54.1	9.17^{ns}
Sasso	38.3	27.3	36.4	34.1	
Local	12.8	0.0	11.4	8.1	
Both Sasso and BB	4.3	4.5	2.3	3.7	

X^2 = chi square; ****** = significant at p≤ 0.01.

the households directly responsible for management and care of chickens.

Moreover, the productive performances interims of number of eggs produced/hen/month, pullet age at first egg laying, current prices that they sold their chickens of pullet, cockerel, hen, cock and as well as husbandry practices were also the core points that has been considered in the process. Average number of eggs will be taken from farmers' estimation of eggs laid/hen/month. Besides these information the survival or mortality rate and preferences of exotic breeds and their products of chickens distributed with the aim of improving poultry productivity of different zones and woredas' in the region was also collected. Primary data was obtained through direct interviewing of selected households or responsible farmers that show how many packages they have taken primarily and how many chickens were there currently as well as their productive performances and marketing values of breeds and their products relative to the indigenous breed.

Data management and analysis

The qualitative and quantitative data sets were analyzed using appropriate statistical analysis procedures. Statistical Package for Social Sciences (SPSS, 2007) version 16.0 was used and analysis of variance (ANOVA) was carried out on some of the quantitative parameters (functional traits). Variables from records on qualitative characters were reported as percentages. Duncan's multiple range test and chi square test were used to compare the results of quantitative traits and to estimate the qualitative variables, respectively.

RESULTS AND DISCUSSION

Types of breeds currently rearing, sources and preferred breeds by farmers

Types of improved chicken the respondents currently rearing and their sources is presented in Table 1. Based on the information gathered from respondents most of the farmers were currently rearing more Sasso breeds 40.4, 72.7 and 47.7% in highland, midland and lowland agro ecologies respectively than Bovans brown. This could be attributed to the availability of Sasso breeds provided by private poultry farm especially by Ethio-chicken private farms.

Government Extension agents, NGO, purchasing from market, purchasing from cooperatives and private farms were the major sources of improved chicken in the studied areas. Accordingly from a total of (135) interviewed 63% was provided through extension, 8.9% was provided by GOs and 7.4% were purchased from market in the form of pullets and cockerels on average in

Table 2. Trait preference of chicken breeds by farmers in all agro-ecology (%).

Parameter	Intensity of preference	Sasso (N=122)	Bovans brown(N=54)	Local (N=97)
Egg production	High	45.9	94.4	13.4
	Medium	27.9	5.6	28.9
	Low	26.2	46.3	57.7
Egg taste	High	9.0	37.0	88.7
	Medium	38.5	16.7	6.2
	Low	52.5	50.0	5.2
Thicker/harder egg shell	High	16.4	37.0	70.1
	Medium	44.3	13.0	23.7
	Low	39.3	24.1	6.2
Body size and meat production	High	97.5	63.0	1.0
	Medium	0.8	13.0	23.7
	Low	1.6	18.5	75.3
Producing chicks with high survival rate	High	7.4	33.3	95.9
	Medium	28.7	48.1	2.1
	Low	63.9	13.0	2.1
Scavenging ability	High	24.6	50.0	86.6
	Medium	37.7	37.0	7.2
	Low	37.7	44.4	6.2
Feed efficiency	High	90.2	51.9	3.1
	Medium	8.2	3.7	26.8
	Low	1.6	27.8	70.1
Disease resistant	High	10.7	48.1	86.6
	Medium	56.2	24.1	11.3
	Low	33.1	38.9	2.1
Physical appearance	High	91.8	55.6	2.1
	Medium	6.6	5.6	33.0
	Low	1.6		64.9

X^2 = chi square; ****** = significant at p≤ 0.01.

all agro-ecologies (Table 1). Around 3.7% of the respondents disclosed that they bought from cooperatives after their age of 45 days. The respondents indicated that they can obtain this breeds easily either by government side or by purchasing from locally organized cooperative and the private farm also gave them through credit. The implication of the current result is that in the absence of government source, there is no lack of the supply of Sasso breeds since the private farm (ethio-chicken poultry farm) gave to them through credit with or without the recognition of government.

Even though each breeds has its own advantages based on different traits mainly on egg production, body size and meat production, scavenging ability, disease resistance and physical appearances; across different agro-ecologies most of the farmers preferred Bovans brown (54.1%) in over all agro ecologies of the study areas followed by Sasso (34.1%) and local breeds (8.1%) (Table 1).

Trait preference of farmers

According to survey conducted farmers identify traits of preference mainly on egg production, body size and meat production, scavenging ability, disease resistance and physical appearance (Table 2). Accordingly 94.4% of respondents on average in all agro ecologies select Bovans brown (Appendix Table 2) for egg production while Sasso breed (Appendix Table 1) was selected by respondents (97.5%) for having large body size and producing high amount of meat. Even though low in production and productivity indigenous chicken (Appendix Table 3) was selected as high for having better egg taste (88.7%), producing chicks with high survival rate or good mothering ability (95.9%), scavenging ability (86.6%) and

Table 3. Breeds adaptability (mean ± SD).

Breed	Agro-ecological zone			Total (N=32)
	Highland (N=114)	Midland (N=113)	Lowland (N=32)	
Sasso received	30.75 ± 22.4	12.00±4	22.67±19.7	22.70±17.9
Sasso survived till production	27.25±22.53	9.33±3.5	17.67±14.6	19.00±16.77
Mortality (%)	11.38	21.8	22.06	16.30
BB received	33.50±25.3	12.00±3.5	22.33±20.03	23.70±19.67
BB survived till production	31.00±27.2	9.33±3.5	17.33±14.98	20.40±19.83
Mortality (%)	7.46	22.25	22.26	13.92

disease resistance (86.6%) traits. This result is in line with the report of Nigussie (2011) in which farmers in different part of Ethiopia mainly select adaptive traits, meat and egg test as their preferred traits. The most important traits of farmers in Jordan were growth rate, disease tolerance, egg yield, body size and fertility (Abdelqader et al., 2007). Majority of the farmers in Kenya considered egg yield as the most important trait followed by mothering ability and body size (Okeno et al., 2011). Identification of traits of economic importance is vital in the development of breeding objectives. Egg production/hen, age at first slaughter (meat yield) and diseases resistance were the farmer's preferred traits to be improved in the study area (Vivian, 2011; Bihan, 2004).

Breeds adaptability

Similar to a breed's demand for vaccination and susceptibility to disease, hardiness and adaptability also depend on origin. Average percent mortality for both breed is higher in lowland agro ecology (Table 3). But on average in three agro ecologies Bovans brown is better adaptive or less mortality until production phase. Poultry production is affected by factors such as breed and strain of chicken used, environmental conditions in poultry house, management practices and feed and feeding management (Bell and Weaver, 2002). Growth and production traits of a bird indicate its genetic constitution and adaptation with respect to the specific environment (Ahmed and Singh, 2007).

Cause of mortality

Cause of mortality for studied breeds (Sasso and Bovans brown) in the study areas were presented in Table 4. According to the respondents high cause of mortality is due to disease 20.2% for Sasso and 31% for Bovans brown followed by predators 11.9 and 13.8% for Sasso and Bovans brown respectively though there were significant difference ($p<0.05$) across agro-ecology for Sasso breeds. Under village poultry production, prevailing diseases, predators, lack of proper health care, poor feeding and poor marketing information were reported as constraint by Moges et al. (2010), Dinka et al. (2010) and Mengesha et al. (2011). The high mortality of chicks under village chicken production in the central highlands of Ethiopia is due to diseases, parasites, predation, lack of feed, poor housing and insufficient water supply (Tadelle, 2001).

Production and productivity of assessed breeds

The average production and reproduction performance of village chicken is shown in Table 5. The information collected on age at first laying disclosed that the mean ages at first laying were 5.9±1.5, 5.7±1 and 7.1±1.6 months for Sasso, Bovans brown and local breeds respectively. The result indicated that Bovans brown chicken breeds reach an age of egg production earlier than Sasso and local breeds which is attributed to breed type difference. This is one of the traits that attributes for the farmers to prefer Bovans brown than Sasso breeds. Birds that reach an age of egg production earlier are supposed to be more efficient on feed consumed (Teketel, 1986).

The average age at first egg laying of local chicken is in line with the result reported by Fisseha et al. (2010) which is 7 months in North West Ethiopia but shorter than Deneke et al. (2015) in South Eastern Oromia region of Ethiopia, Addisu et al. (2014) in North Wollo zone of Amhara region of Ethiopia and Solomon et al. (2013) North West Ethiopia, in Meketel Zone which are 5.48-6.50, 4.76 and 5.2±1.16, respectively. The current study revealed average first egg lay of Sasso breeds under farmers' management condition is relatively later in age at first lay than the study of Desalew (2012) which reported 5.35 ± 0.45, 5.52 ± 0.44 and 5.11± 0.2 months for Isa Brown, Bovans Brown and Potchefstroom Koekoek respectively under village production system in East Shoa, Ethiopia.

The result in the current study revealed that the average egg production per month of Bovans brown (22.2) is higher than that of Sasso (16.2) and local chickens (12.6). The current result of egg production of Bovans Brown was in line with Dasalew (2012) reported for Bovans brown 266.32±8.7 but relatively lower and

Table 4. Causes of breed mortality.

Breed	Causes of mortality	Agro-ecological zone			Total (N=109)	X^2
		Highland (N=35)	Midland (N=41)	Lowland (N=33)		
Sasso	Mechanical	2.9	2.4	9.1	4.6	36.40*
	Disease	25.7	7.3	30.3	20.2	
	Predators	20.0	7.3	9.1	11.9	
	Mechanical and Disease	0.0	2.4	0.0	0.9	
	Mechanical and predators	2.9	9.8	0.0	4.6	
	Disease and predators	11.4	2.4	9.1	7.3	
	No mortality	22.9	65.9	30.3	41.3	
	Lack of management	5.7	2.4	0.0	2.8	
	Disease and thief	5.7	0.0	6.1	3.7	
	Mechanical, disease and predators	2.9	0.0	3.0	1.8	
	Thief	0.0	0.0	3.0	0.9	
Bovans Brown		**N=11**	**N=5**	**N=13**	**N=29**	
	Disease	54.5	0.0	23.1	31.0	21.50
	Predators	9.1	0.0	23.1	13.8	
	Mechanical and disease	9.1	0.0	0.0	3.4	
	Mechanical and predators	9.1	40.0	0.0	10.3	
	Disease and predators	9.1	20.0	0.0	6.9	
	No mortality	9.1	40.0	23.1	20.7	
	Stress	0.0	0.0	7.7	3.4	
	Mechanical, disease and predators	0.0	0.0	23.1	10.3	

X^2 = chi square; ****** = significant at p≤ 0.01.

higher than 276.1±11.3 and 187.04±13.49, respectively, for Isa Brown and Potchefstroom Koekoek respectively under village production system in East Shewa, Ethiopia. According to the respondents, the average age of slaughter in all agro ecologies showed that Sasso (5.3±1.3 months) chicken breed earlier to reach slaughter than Bovans Brown (6.6±1.3 months) and local (9.9±1.9 months) chicken breeds. This indicates that Sasso seems to reach slaughter age earlier than Bovans brown and local chicken breeds.

Constraints of improved chicken production in study areas

Most respondents frequently mentioned feed shortage as the first ranked chicken production constraint in all districts (25.4%) whereas predators (20.1%) were the second and disease was the third constraints in overall agro ecologies though there were significant ($p<0.05$) differences among agro ecologies (Table 6). Due to these mentioned constraints, the farmers did not achieve sustainable improvements from the local and improved exotic breeds and/or the cross-breeds. Similar results were reported by different scholars at different parts of the country contrary or similar to the current reports on constraints of local or improved exotic and/or cross breed chicken production under farmers management condition.

Fisseha (2009), Hassen (2007), Bogale (2008) and Addis et al. (2013) reported disease, predation, market system, management and production system were major constraints of chicken production in Ethiopia and identified diseases as the first ranked chicken production constraints in all districts whereas predators like snacks as the third problem in Tach Armachiho and Quara districts. Tadelle et al. (2001) also reported that high mortality of chicks due to diseases, parasites, predation, lack of feed, poor housing and insufficient water supply was the major constraints in village chicken production in the central highlands of Ethiopia. Similarly, Moges et al. (2010), Dinka et al. (2010) and Mengesha et al. (2011) under village poultry production reported prevailing diseases, predators, lack of proper health care, poor feeding and poor marketing information as major constraints.

Opportunities of improved chicken production in study areas

The major opportunities of improved chicken production in the study areas are presented in Table 7. Even if many constraints were raised by respondents in the study area there were also some opportunities to improve village

Table 5. Production and productivity of assessed breeds (Mean and SD).

Parameter	Agro-ecological zone	N	Mean	Minimum	Maximum	Std. deviation
Average age at first egg lay Sasso (month)	Highland	38	5.9	3.0	9.0	1.5
	Midland	36	5.7	3.5	8.0	1.6
	Lowland	34	6.0	4.0	9.0	1.4
	Total	108	5.9	3.0	9.0	1.5
Average age at first egg lay Bovans Brown (month)	Highland	18	5.6	4.0	6.0	0.6
	Midland	12	5.6	5.0	7.0	0.8
	Lowland	13	6.0	4.0	10.0	1.5
	Total	43	5.7	4.0	10.0	1.0
Average age at first egg lay local (month)	Highland	16	7.2	3.5	12.0	2.0
	Midland	12	6.4	6.0	8.0	0.7
	Lowland	7	8.1	7.0	10.0	1.3
	Total	35	7.1	3.5	12.0	1.6
Average egg production per month Sasso	Highland	34	17.6	10.0	30.0	5.0
	Midland	36	16.8	10.0	25.0	4.8
	Lowland	32	14.2	3.0	25.0	4.9
	Total	102	16.2	3.0	30.0	5.1
Average egg production per month Bovans Brown	Highland	20	23.3	10.0	30.0	5.7
	Midland	12	21.0	18.0	24.0	2.2
	Lowland	12	21.7	16.0	30.0	5.6
	Total	44	22.2	10.0	30.0	4.9
Average egg production per month Local	Highland	14	11.0	7.0	20.0	3.9
	Midland	12	11.1	10.0	15.0	2.0
	Lowland	8	17.5	8.0	25.0	5.3
	Total	34	12.6	7.0	25.0	4.6
Average age at slaughter of Sasso (month)	Highland	35	5.6	2.0	9.0	1.6
	Midland	26	4.8	4.0	7.0	0.8
	Lowland	33	5.5	3.0	8.0	1.1
	Total	94	5.3	2.0	9.0	1.3
Average age at slaughter of BB (month)	Highland	17	7.2	6.0	9.0	1.1
	Midland	12	6.1	5.0	7.0	0.7
	Lowland	11	6.0	4.0	9.0	1.5
	Total	40	6.6	4.0	9.0	1.3
Average age of slaughter local (month)	Highland	16	9.8	6.0	12.0	2.1
	Midland	1	7.0	7.0	7.0	.
	Lowland	8	10.4	9.0	12.0	0.9
	Total	25	9.9	6.0	12.0	1.9

chicken production and productivity for the future such as good government attention, breed availability, market availability and training and extension service. Good government attention was the primary opportunities (34.2%) for the sector improvement followed 10, 5 and 2.5% of opportunities for improved chicken production under farmers management condition breed availability, market access and chicken meat eating habits and presence of good credit and saving services respectively. Government emphasis towards the development of

Table 6. Constraints of improved chicken production in study areas (%).

Parameter	Agro-ecological zone			Total (N=134)	X^2
	Highland (N=47)	Midland (N=44)	Lowland (N=43)		
Feed shortage	27.7	6.8	41.9	25.4	83.35***
Disease	4.3	4.5	4.7	4.5	
Predators	4.3	52.3	4.7	20.1	
Lack of market access	0.0	0.0	2.3	0.7	
Feed shortage and disease	12.8	0.0	23.3	11.9	
Feed shortage and predators	10.6	11.4	2.3	8.2	
Feed shortage, disease and predators	19.1	13.6	9.3	14.2	
Feed shortage, disease, predators, lack of market access and thief	0.0	0.0	9.3	3.0	
Housing facility	2.1	0.0	0.0	0.7	
Disease and thief	2.1	0.0	0.0	0.7	
Lack of knowledge	2.1	2.3	0.0	1.5	
Lack of feeds and market access	4.3	4.5	2.3	3.7	
Feed shortage, disease, predators and thief	2.1	0.0	0.0	0.7	
Feed shortage, disease and thief	6.4	0.0	0.0	2.2	
Poor management	2.1	4.5	0.0	2.2	

X^2 = chi square; ** = significant at p≤ 0.01.

Table 7. Opportunities of improved chicken production in study areas (%).

Parameter	Agro-ecological zone			Total (N=120)	X^2
	Highland (N=47)	Midland (N=30)	Lowland (N=43)		
Market access	4.3	0.0	9.3	5.0	59.26***
Chicken meat eating habits	6.4	3.3	4.7	5.0	
Good government attention	23.4	50.0	34.9	34.2	
Breed availability	14.9	0.0	11.6	10.0	
Presence of good credit and saving services	2.1	0.0	4.7	2.5	
Market access, good government attention, breed availability and presence of good credit and saving services	4.3	3.3	2.3	3.3	
Market access, good government attention and breed availability	0.0	0.0	2.3	0.8	
Good government attention and presence of good credit and saving services	14.9	0.0	2.3	6.7	
Market access and good government attention	10.6	23.3	0.0	10.0	
Breed availability and presence of good credit and saving service	6.4	0.0	2.3	3.3	
Good government attention and breed availability	6.4	0.0	7.0	5.0	

Table 7. Contd.

Market access and breed availability	6.4	0.0	9.3	5.8
Market access and presence of good credit and saving services	0.0	0.0	7.0	2.5
Increasing chicken meat eating habit and good government attention	0.0	20.0	2.3	5.8

X^2 = chi square; ****** = significant at p≤ 0.01.

trained manpower, infrastructure (electricity, road etc.) and establishment of different institutions focusing on livestock sector especially the poultry sub-sector to enhance its contribution to country's economy and food security were opportunities of chicken production in the country (EIAR, 2015).

Better understanding of these constraints and good prospects of improved exotic and/or cross or local chicken production is important to improve food security and improves the standard of living condition of the farmers.

Conclusion

The result of the current survey indicated that the production and productivity of the Sasso chicken breed distributed by ethio-chicken private farms under farmer management condition is better than indigenous chicken. But lower than the Bovans brown breed interims of egg production, disease resistibility. Also scavenging ability, feed consumption egg taste of Bovans brown is better than Sasso following indigenous chicken. By these traits farmers in most study areas or agro-ecologies prefers Bovans brown breeds. However, by growth performance or body size development, Sasso breeds are relatively better than Bovans brown breeds. Therefore, for Sasso breed to conclude it is broiler or not further investigation is needed/should be done on station level before distribution. In addition to this, the Sasso breeds currently distributed to the farmers by the ethio-chicken private farms is the cross (F1) of SA51A (female) and T44 (male). Hence the breed general management, production and productivity, nutritional management and health guidelines were not known. To have a clear understanding of the performance of Sasso breeds, on-farm and on-station controlled experiment on management practices and feeding strategy is important.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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APPENDIX

Table 1. Response of respondents on Sasso for given traits in study areas (%).

Parameter (Sasso)		Agro-ecological zone			Total (N= 122)	X^2
		Highland (N=40)	Midland (N= 42)	Lowland (N= 40)		
Egg production	High	47.5	40.5	50.0	45.9	2.9
	Medium	25.0	26.2	32.5	27.9	
	Low	27.5	33.3	17.5	26.2	
How is sasso on eggs testing?	High	12.5	9.5	5.0	9.0	12.40***
	Medium	22.5	57.1	35.0	38.5	
	Low	65.0	33.3	60.0	52.5	
Sasso on thicker/harder shell	High	25.0	11.9	12.5	16.4	15.58***
	Medium	30.0	66.7	35.0	44.3	
	Low	45.0	21.4	52.5	39.3	
How is sasso on body size and meat?	High	100.0	95.2	97.5	97.5	5.91
	Medium	0.0	0.0	2.5	0.8	
	Low	0.0	4.8	0.0	1.6	
How is sasso on chicks survival rate?	High	12.5	7.1	2.5	7.4	12.51***
	Medium	22.5	16.7	47.5	28.7	
	Low	65.0	76.2	50.0	63.9	
How is sasso on scavenging?	High	35.0	16.7	22.5	24.6	6.63
	Medium	40.0	33.3	40.0	37.7	
	Low	25.0	50.0	37.5	37.7	
How is sasso on feed efficiency?	High	97.5	85.7	87.5	90.2	3.79
	Medium	2.5	11.9	10.0	8.2	
	Low	0.0	2.4	2.5	1.6	
How is sasso disease resistant?	High	15.4	7.1	10.0	10.7	24.60***
	Medium	41.0	85.7	40.0	56.2	
	Low	43.6	7.1	50.0	33.1	
How is sasso on physical appearance?	High	92.5	85.7	97.5	91.8	4.27
	Medium	5.0	11.9	2.5	6.6	
	Low	2.5	2.4	0.0	1.6	

Table 2. Response of respondents on Bovans brown for given traits in study areas (%).

Parameter		Agro-ecological zone			Total (N=54)	X2
		Highland (N=24)	Midland (N=15)	Lowland (N=15)		
How is BB on egg production?	High	95.8	86.7	100.0	94.4	2.7
	Medium	4.2	13.3	0.0	5.6	
How is BB on producing better egg taste?	High	33.3	80.0	33.3	46.3	12.20***
	Medium	37.5	20.0	53.3	37.0	
	Low	29.2	0.0	13.3	16.7	
How is BB on producing harder egg shell?	High	33.3	73.3	53.3	50.0	7.09
	Medium	45.8	26.7	33.3	37.0	
	Low	20.8	0.0	13.3	13.0	
How is BB on body size and meat?	High	25.0	6.7	40.0	24.1	7.65
	Medium	62.5	66.7	60.0	63.0	
	Low	12.5	26.7	0.0	13.0	
How is BB on producing chicks with high survival rate?	High	25.0	13.3	13.3	18.5	2.03
	Medium	33.3	26.7	40.0	33.3	
	Low	41.7	60.0	46.7	48.1	
How is BB on scavenging?	High	12.5	0.0	26.7	13.0	5.96
	Medium	45.8	53.3	53.3	50.0	
	Low	41.7	46.7	20.0	37.0	
How is BB on feed efficiency?	High	50.0	20.0	60.0	44.4	7.38
	Medium	45.8	80.0	33.3	51.9	
	Low	4.2	0.0	6.7	3.7	
How is BB on disease resistance?	High	29.2	13.3	40.0	27.8	10.20**
	Medium	33.3	80.0	40.0	48.1	
	Low	37.5	6.7	20.0	24.1	
How is BB on Physical appearance?	High	33.3	26.7	60.0	38.9	4.51
	Medium	62.5	66.7	33.3	55.6	
	Low	4.2	6.7	6.7	5.6	

Table 3. Response of respondents on local breeds for given traits in study areas (%).

Parameter		Agro-ecological zone			Total (N=97)	X^2
		Highland (N=43)	Midland (N=15)	Lowland (N=39)		
How is a local breed on egg production?	High	9.3	0.0	23.1	13.4	14.79***
	Medium	41.9	6.7	23.1	28.9	
	Low	48.8	93.3	53.8	57.7	
How is local on egg tastes?	High	90.7	80.0	89.7	88.7	1.71
	Medium	4.7	13.3	5.1	6.2	
	Low	4.7	6.7	5.1	5.2	
How is local on producing thicker egg shell?	High	79.1	6.7	84.6	70.1	48.00**
	Medium	14.0	93.3	7.7	23.7	
	Low	7.0	0.0	7.7	6.2	
How is local on body size and meat?	High	0.0	0.0	2.6	1.0	7.33
	Medium	30.2	0.0	25.6	23.7	
	Low	69.8	100.0	71.8	75.3	
How is local on producing chicks with high survival rate?	High	95.3	100.0	94.9	95.9	0.78
	Medium	2.3	0.0	2.6	2.1	
	Low	2.3	0.0	2.6	2.1	
How is local on scavenging behavior?	High	86.0	100.0	82.1	86.6	5.25
	Medium	4.7	0.0	12.8	7.2	
	Low	9.3	0.0	5.1	6.2	
How is local on feed efficiency?	High	0.0	0.0	7.7	3.1	11.89*
	Medium	30.2	0.0	33.3	26.8	
	Low	69.8	100.0	59.0	70.1	
How is local on disease resistance?	High	100.0	33.3	92.3	86.6	56.94***
	Medium	0.0	66.7	2.6	11.3	
	Low	0.0	0.0	5.1	2.1	
How is local on physical appearance?	High	0.0	.0	5.1	2.1	9.39
	Medium	41.9	6.7	33.3	33.0	
	Low	58.1	93.3	61.5	64.9	

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Dairy cattle milk production, handling, processing, utilization and marketing system in Bench Maji Zone, Southwest Ethiopia

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The study was conducted to assess the general milk production system, handling practices, processing, utilization and marketing system of raw cow milk produced in Mizan Aman, Debub and Shey Bench Districts. A total of 270 respondents (thirty respondents from each study area) were selected using simple random sampling technique and interviewed by using a semi structured questionnaires. The results of current study showed that the respondents of Shey Bench and Debub Bench were entirely (100%) engaged in farming activities, predominately mixed production system. Similarly, majority (82.2%) of the respondents of Mizan Aman were also pre-dominantly involved in mixed crop livestock production while the remaining 17.8% were involved only in Peri-urban production system. Majority of the respondents in the three districts (91.1, 100 and 90% of Mizan Aman, Debub and Shey Bench) had dairy cows from 1 to 5, some had from 6 to 10 and 11 to 15. About 95.6, 94.4 and 78.9% of the respondents in Mizan Aman, Debub and Shey Bench use plastic buckets for milking. As reported by most of the respondents (95.6, 58.9 and 55.6% of Mizan Aman, Debub and Shey Bench districts, respectively), clay pot is used for storage of milk until the wanted amount is accumulated for processing. About 60.0, 26.7 and 20.0% of the respondents utilize raw milk or fresh milk in Mizan Aman, Debub and Shey Bench districts, respectively. Majority of the respondents (97.8, 92.2 and 70.0% in the Mizan Aman, Debub and Shey Bench districts) reported that scarcity of milk is the main problem of milk and milk products marketing in the study areas. The common milk production constraints and prioritized by the sampled farmers were shortage of feed and scarcity of land, diseases, accessibility to marketing place, limitation of market information and inadequate infrastructure. Therefore, it was concluded that the majority of the milk produced in the study areas were not processed, marketed and mainly utilized by household family for home consumption. These suggest the need for enriched dairy cattle production scheme in the study areas.

Key words: Bench Maji, milk handling, raw milk, utilization of milk.

INTRODUCTION

Ethiopia is a home for an estimated 56.71 million cattle, 29.11 million goats, 29.33 million sheep, 2.03 million

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Figure 1. Study area map.

horses, 7.43 million donkeys, 0.4 million mules, 56.87 million chicken and 1.16 million camels (CSA, 2015). However, the productivity of the livestock resources and the benefits obtained from the sector do not commensurate with the high livestock population. Given the considerable potential for smallholder income and employment generation from high-value dairy products, development of the dairy sector in Ethiopia can contribute significantly to poverty alleviation and nutrition in the country (Mohammed et al., 2010).

A small amount of milk is produced by a large number of small holder dairy producers, but low marketable outputs in Ethiopia hinder the possibilities of exploiting distant but rewarding markets due to high transaction costs arising from transportation and high opportunity costs of labor involved. As reported by Muriuki and Thorpe (2008), the vast majority `of milk produced outside urban centers in the country are processed into milk products at household level using traditional technologies such as *Ergo* (Ethiopian naturally fermented milk), butter, ghee and *Ayib* (Ethiopian cottage cheese) that are marketed through informal channel. In areas where the climate is hot and humid, the raw milk gets easily fermented and spoiled during storage unless it is refrigerated or preserved. However, such storage facilities are not readily available in rural areas and cooling systems are not feasible due to lack of the required dairy infrastructure and when available they are too costly for poor smallholder producers (O'Mahony and Peters, 2004).

Dairy products are essential for family consumption and serve as source of income when sold as butter and Ayib (Ethiopian cottage cheese). Due to small volume of daily milk produced, producers keep milk produced over 3 to 4 days until sufficient amount is accumulated to be processed into more shelf stable products. In Mizan Aman town, Debub and Shey Bench districts, traditional milk production, processing and handling are a common practice. Traditional milk products are generally reported as substandard quality mainly due to inadequate dairy infrastructure such as refrigeration facility and clean water and limited knowledge of the hygienic handling of milk and milk products. This necessitates better understanding of the traditional processes and handling of milk and milk products, which is a prerequisite for development. Even though milk production represents an essential part of the livelihood of the rural and urban community in targeted areas, there are no documented data on milk processing, handling, utilization and marketing. Understanding the prevailing traditional practices of milk production, processing and storage is of paramount importance to make future improvement interventions. Therefore, the objectives of this study are to assess milk production system, handling practices, utilization and marketing systems and to identify the major constraints and opportunities of milk production in Bench Maji Zone.

MATERIALS AND METHODS

Description of the study area

Bench Maji Zone is one of the 13 zones of the Ethiopian Southern Nations, Nationalities and Peoples Region. The administrative center of Bench Maji Zone (BMZ) is Mizan-Teferi which is found at a distance of about 561 km from Addis Ababa and 830 km from Hawassa (regional capital city). It is bordered with Keffa Zone in North, Debub Omo in North East direction, Sheka Zone in South West, with Gambela and South Sudden Republic in South direction (BMZFED, 2015) (Figure 1).

Agro-ecologically, Bench Maji Zone consists of 52% lowland (<1500 meter above sea level (masl), 43% mid altitude (1500-2300 masl) and 5% highland (>2300 masl). The altitude ranges from 500 to 3,000 masl. Bench Maji zone is found at 34°45' to 36°10' East and 5°40' to 7°40' North. The annual average temperature ranges from 15.1 to 27.5°C, while the annual rainfall ranges from 400 to 2,000 mm (BMZFED, 2015). Majority of the population depend on crop production, animal production and beekeeping. The main livestock species reared in the zone are cattle, sheep, goats, poultry and equines. About 324,442 cattle, 152,648 sheep, 80,996 goats, 9, 629 horses, 1,012 mules, 1,193 donkeys, 494,180 chicken and 82,969 beehives are estimated to be found in the zone according to the report of CSA (2015).

Sample size and sampling techniques

The current study was conducted in Mizan Aman town, Debub and Shey Bench districts, focusing on the potential area of milk and the amount of raw cow milk marketed in the study areas. Districts, *kebeles* and households were selected to undertake survey on milk production potential or dairy cow possessions and where milk is widely sold through informal channels. Accordingly, 3 *kebeles* were selected from each district using purposive sampling techniques. From each selected *kebele,* thirty households were randomly selected based on the number of cows, milk production potential, interest of households to take part in the study. A total of 270 respondents were selected using simple random sampling technique and interviewed by using a semi structured interviews.

Sources and methods of data collection

Both primary and secondary data collection methods were used to achieve the objectives of this study. Primary data were collected from all randomly selected 270 households who raised dairy cattle by using semi- structured kind of interview, questionnaire and field observation. In addition, informal surveys in the form of group discussion were conducted with *kebeles* administers and extension workers to acquire relevant information. Those enumerators who are fluent in the local language were employed as well as on the trends of the contents of the questionnaire and techniques of interviewing. Soon after training, data collection started under the close supervision of the researcher in order to minimize data collection error. Secondary data were also collected from written documents of agricultural office of each *woreda* and *kebele*, books and journals.

Data analysis

Quantitative and qualitative data analyses were done for the data collected. Simple descriptive statistics such as frequency, percentage and mean were used to analyze data using SPSS for windows version 20 (SPSS, 2011) and the result is presented in form of table.

RESULTS AND DISCUSSION

General characteristics of households dairy cow producers

Dairy cow production in Benchi Maji Zone, like in other developing countries, is categorized by subsistent type. The herd was dominated with unimproved local breeds. The general characteristics of respondents in the study areas are presented in Table 1. The average age of household and family size per household was 38.47±1.31 years and 5.93±0.15 persons, respectively. The age and family size reported in this study is lower than that of Belay et al. *(*2012) who stated the average age and family size of 51.26±10.99 and 6.02±2.52 persons, respectively.

The majority (47.4%) of the household heads had no formal education, while 38.5, 6.0, 4.4, 3.3 and 0.4 had primary school, junior secondary school, senior secondary school, college and university, respectively (Table 1). The percentage of household heads possessing college and university level education were lower than the report of Belay et al. *(*2012) around 35.2 and 7.4, respectively in Jimma, Southwestern part of Ethiopia.

The study revealed that the dairy production was mainly engaged by a male domain (84.4%), whereas only 15.6% were females. The dominance of male-headed household reported in current finding is in agreement with early findings of Belay et al. *(*2012) who described 75.9% males. Majorities (88.9) of the respondent heads were married and some of the respondent heads were unmarried (4.4%) and widows (6.7%). As indicated in Table 1, the respondents were engaged in different occupations such as household wives (20%), farmers (48.1%), civil workers (24.4%) and other businesses (7.4%).

Milk production

The milk production system, species and sources of milk consumption in the study area are portrayed in Table 2. The results of present study showed that the respondents of Shey Bench and Debub Bench were entirely (100%) engaged in agricultural activities dominated by mixed production system; similarly, majority (82.2%) of the respondents of Mizan Aman were pre- dominately involved in mixed crop livestock production while the remaining 17.8% were involved only in Peri-urban production system. Dairy cattle production is a crucial component of the mixed farming system. They were kept as sources of draft power, milk, meat, skin and hides, and they are also the main sources of income and are closely linked to the social and cultural lives of the community.

As indicated in Table 2, majority of households from the three *districts* (83.3, 94.4 and 90% of Mizan Aman, Debub and Shey Bench, respectively) consumed milk produced from home or own dairy cows. However, 16.7, 5.6 and 10% of the respondents in Mizan Aman, Debub and Shey Bench, respectively obtained from neighboring milk producers. The major livestock reared in the area were cattle, sheep and poultry. As an integral part of the mixed farming system, dairy cattle production plays a substantial role in the household milk production or among different animal species cow milk production was the common for consumption and marketing as well.

Almost all the respondents in the three *districts* (91.1, 100 and 90% of Mizan Aman, Debub and Shey Bench, respectively) had dairy cows from 1 to 5 and some had from 6 to 10 and 11 to 15. A few respondents (1.1%) in the Shey Bench had from 16 to 20 dairy cattle. This result is in line with early results of Lemma (2004) who reported that 3.2, 3.1 and 2.2 for Adami Tulu Jido Kombolcha, Arsi Negele and Lume districts, and also in agreement with the report of Tesfaye (2007) which indicated 3.0±0.15 cows holding in Metema District. Smaller dairy cow holding in the current study could be justified by reduction in grazing land due to expansion of cultivation land, and

Table 1. Social characteristics of the respondents in the study area (n=270).

Socio-economic characteristics	Frequency	Mean±SD
Age	270	38.47±1.31
Family size	270	5.93±0.15
Level of education		**Percentage**
No formal education	128	47.4
Primary school	104	38.5
Junior Secondary school	16	6.0
Senior secondary School	12	4.4
College	9	3.3
University	1	0.4
Gender		
Male	228	84.4
Female	42	15.6
Marital status		
Married	240	88.9
Unmarried	12	4.4
Widows	18	6.7
Owners occupation		
Household wife	54	20.0
Farmer	130	48.1
Civil worker	66	24.4
Business	20	7.4

n= Number of respondents.

Table 2. Milk production system and sources of milk consumption in the study area (n=270).

Variable	Districts		
	Mizan Aman (n=90)	Debub Bench (n=90)	Shey Bench (n=90)
	Percentage		
Production system			
Crop-livestock mixed	82.2	100	100
Peri-urban	17.8	-	-
Source of milk consumed			
Home produced	83.3	94.4	90
Neighbor milk producers	16.7	5.6	10
Dairy cooperatives	-	**-**	**-**
Animal species for milk			
Cow	100	100	100
Sheep	**-**	-	**-**
Goat	**-**	-	**-**
The average dairy cows per households			
1-5	91.1	100	90
6-10	5.6	**-**	8.9
11-15	3.3	**-**	-
16-20	-	**-**	1.1

n= Number of respondents.

Table 3. The milking procedure which followed by households in the study area (n=270).

Milking procedure	Districts		
	Mizan Aman (n=90)	Debub Bench (n=90)	Shey Bench (n=90)
	Percentage		
Technique of milking			
Washing teat	1.1	1.1	3.3
Calf suckling	98.9	98.9	96.7
Frequency of milking			
Once a day	-	2.2	1.1
Twice a day	100	97.8	98.9
Practice of washing the udder and teats before milking			
Yes	40	14.4	16.7
No	60	85.6	83.3
Practice of cleaning containers before and after milking			
Yes	32.2	90	88.9
No	67.8	10	11.1
Barn hygiene/cleaning			
Daily basis	48.9	65.6	51.1
Once a week	25.6	1.1	36.7
Twice a week	20	32.2	8.9
Three times per week	5.6	1.1	3.3

n = Number of respondents.

Population growth was forced to reduce their cattle number.

Hygienic condition of milk

Milking practice

All the respondents milk their cows by using hand milking either by washing cow teats or letting calf to suckle its dam for minutes to stimulate milk let-down. About 98.9, 98.9 and 96.7% of dairy producers milk their cows using hand milking after calf suckling in Mizan Aman, Debub and Shey Bench, respectively, whereas, a few respondents milk their cows by solely washing teats (Table 3).

As indicated in Table 3, all of the household milk producers at Mizan Aman and the majority of dairy cow producers at Debub Bench (97.8%) and Shey Bench (98.9%) milk their cows twice a day (morning and evening), while the cows are in the barn or under a tree shade. However, some of the respondents (2.2 and 1.1% of Debub Bench and Shey Bench, respectively) milk their cows once a day. This might be due to late stage of lactation. Most of the household milk producers do not clean the udder and teats of cows before milking. About 40, 14.4 and 16.7% of household milk producers in Mizan Aman, Debub and Shey Bench wash the teats and udder of the cows before milking. Washing of udder and teats before milking is not practiced; besides most households milk producers let the calf to suckle before milking and they believe that during calf suckling, the teats get washed by the saliva of the calf. Even though most of the household milk producers in the study areas wash their containers before and after milking, poor hygienic milking area and failure to use separate towel for individual cows can lead to high contamination of the milk with pathogenic microorganisms.

The practice of cleaning milking areas (barn and under a tree shade) varies among households. Accordingly, about 48.9, 65.6 and 51.1% of the respondents clean milking area on daily basis, 25.6, 1.1 and 36.7% clean once a week, 20, 32.2 and 8.9% clean twice a week and 5.6, 1.1 and 3.3% clean three times per week in Mizan Aman, Debub and Shey Bench. Food Hygiene Regulations (2006) reported that the milking area must minimize the risk of contamination from any source, including dust, flies, birds or other animals. However, in the present study, milking was usually done under poor hygienic condition and most of the households did not have separate place for milking. This may increase the bacterial contamination of milk from the milking environment.

Milk handling practices

The type of utensils used for milking, transportation,

Table 4. Milk handling practices in the study area (n=270).

Variable	Districts		
	Mizan Aman (n=90)	Debub Bench (n=90)	Shey Bench (n=90)
	Percentage		
Types of containers used for milking			
Plastic buckets	95.6	94.4	78.9
Nickel (Aluminum)	3.3	5.6	18.9
Stainless steel	1.1	-	2.2
Milk utensils used for storage (%)			
Clay pot (Ensira)	95.6	58.9	55.6
Kele	4.4	41.1	44.4
Methods of cleaning milk containers			
Washing	65.6	74.4	96.7
Smoking	1.1	-	-
Both	33.3	25.6	3.3
Water sources			
Tap water	33.3	3.3	3.3
Hand dug well water	53.3	45.5	21.1
River	13.3	50	75.6
Type of plants used for cleaning milking equipment's			
Kosorote (ocimum haardiense)	18.9	18.9	16.7
Tej sar (Cymbopogan martini)	45.6	57.8	40.0
Tenadem (Ruta chalepensis)	20.0	15.5	10.0
Woyira (Olea africana)	15.5	7.8	33.3

n = Number of respondents.

collection and storage of milk by milk sellers was found to be different (Table 4). Most of them used plastic buckets, Nickel (Aluminum) and the rest used stainless steel. As indicated in Table 4, about 95.6, 94.4 and 78.9% respondents in Mizan Aman, Debub and Shey Bench use plastic buckets for milking. Whereas, 3.3, 5.6 and 18.9% of respondents used Nickel (Aluminium) made containers for milking and collection in Mizan Aman, Debub and Shey Bench. However, a few percent (1.1 and 2.2% of Mizan Aman and Shey Bench) of respondents adopted stainless steel. This is in line with the findings of Yitaye et al. (2009), Teklemichael (2012) and Teshome et al. (2014) who reported that 83% of the surveyed urban dairy farms in Bahir Dar and Gondar, 75% of the surveyed in Dire Dawa town and Shashemene town used plastic utensils. Additionally, milkers dip their fingers in the milking vessel and moistening teats of the cows with the intention of facilitating milking. However, such practice may cause microbial contamination of the milk from the milkers' hand.

The interviewed households used different utensils for milk storage and processing. All respondents reported using clay pot (*Ensira*) for milk storage and churning (butter-making). As reported by most of the respondents (95.6, 58.9 and 55.6% of Mizan Aman, Debub and Shey Bench, respectively), clay pot is also used for storage of milk until the needed amount is accumulated for processing. Abebe et al. (2012) portrayed similar result where 88.3 and 96.7% in Dega and Woina dega agro-ecology in Ezha District of the Gurage Zone, Southern Ethiopia was obtained. As indicated by respondents, clay pot keeps milk well at the prevailing high ambient temperature compared to plastic containers. Whereas, some of the respondents use *Kele* (kind of utensil made up from local available hollowed woody) for milk storage and process (Table 4).

As indicated in Table 4, majority of the respondents (65.6, 74.4 and 96.7% of Mizan Aman, Debub and Shey Bench) washed milk containers with water without smoking techniques. However, 33.3, 25.6 and 3.3% of Mizan Aman, Debub and Shey Bench were using both washing and smoking techniques for cleaning milk containers. The majority of the respondents (50 and 75.6%) used river followed by hand dug well water (45.5 and 2.1%) and tap water (3.3 and 3.3%) in Debub and Shey Bench. Moreover, most of the respondents of Mizan Aman used hand dug well water (53.3%) followed by tap water (33.3%). In the current study areas, the quality of

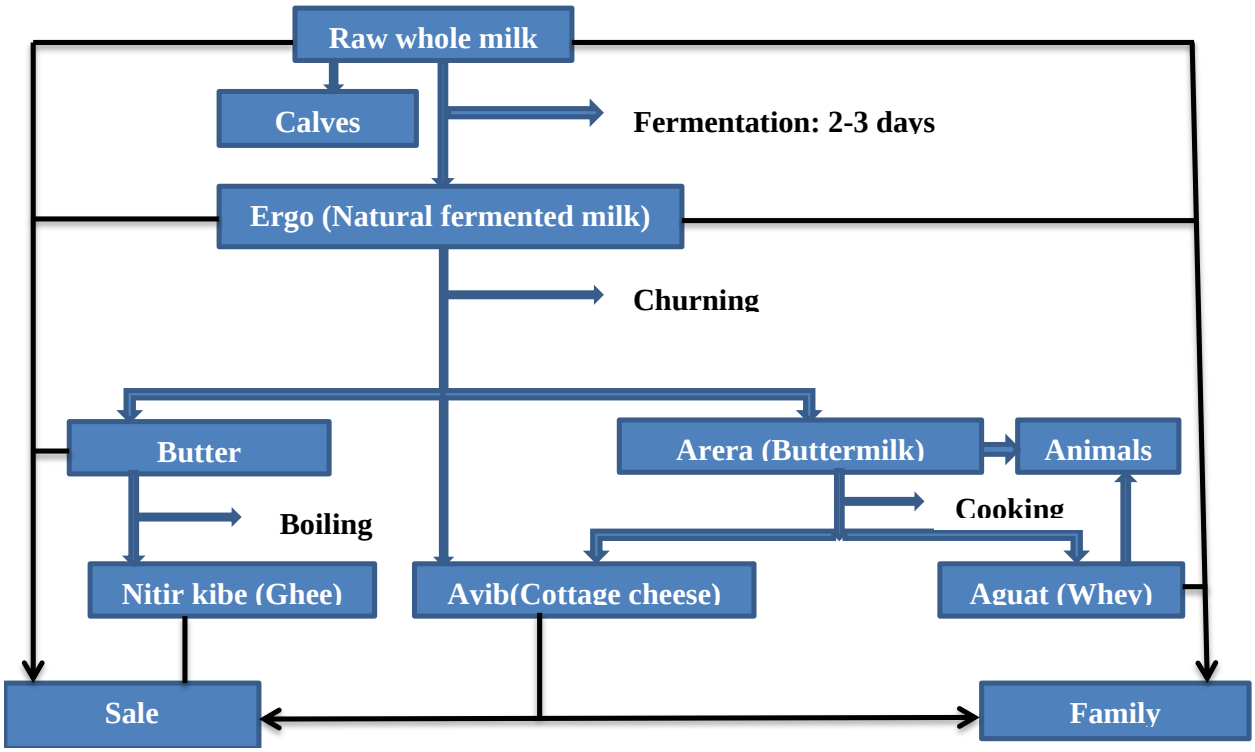

Figure 2. The process and utilization of milk and milk products in the study areas.

both river and hand dug well waters used for cleaning may not satisfy the recommended standard, thus can attribute to the poor quality of milk.

Smoking of milking and storage containers was done by using Kosorote (*Ocimum haardiense*), Tej sar (*Cymbopogan martini*), Tenadem (*Ruta chalepensis*) and wood splinters of 'Weyira' (Olea africana) in the areas (Table 4). They mentioned that smoking is used to develop desirable flavor and aroma, increase shelf life of milk and facilitate fermentation. In addition to imparting pleasant flavor, it facilitates fermentation and increases shelf-life of milk and milk products. Smoking has anti-microbial activity, thus inhibits the growth of microorganisms in milk (Mogessie and Fekadu, 1993 cited in Teshome et al., 2014).

Milk and milk products utilization and marketing

Similar to other rural parts of Ethiopia, the common milk products manufactured and utilized in this study areas include raw milk, butter, Ayib (cottage cheese), whey (Aguate), Ergo (naturally fermented milk) and buttermilk (Arrera). As observed in the current study, about 60.0, 26.7 and 20.0% of respondents utilize raw milk or fresh milk in Mizan Aman, Debub and Shey Bench. Compared to Debub and Shey Bench districts, the majority of respondents in Mizan Aman utilize fresh milk more than other milk products. This might be the presence of proximate milk marketing place. All of the respondents produce traditional butter from naturally fermented whole milk (6.6, 20.0 and 13.3% of respondents produced butter in Mizan Aman, Debub and Shey Bench). Figure 2 depicts the process and utilization of milk and milk products in the study areas.

The study revealed that the majority (26.7%) of the respondents in the Shey Bench process raw milk into cottage cheese (*Ayib*) compared to the rest two *districts*. From different milk products butter and Ayib have better shelf life and fetch better market price. About 6.7 and 16.7% of the respondents in the Debub and Shey Bench areas used whey (Aguat) for household consumption and animals drinking particularly calves (Figure 2). In study areas, the surplus milk was processed for home consumption and marketing. This finding agreed with the report of Lemma (2004) who indicated that milk was processed to increase the family income through sale, diversify the products for consumption and to increase the shelf life of the products.

The means of milk transportation depend on the distance that milk producers were located (Table 5). Milk sellers away from marketing place like small shops/kiosks and hotels/cafeteria use Bajaj (6.7%) in Mizan Aman and the sellers close to marketing place transport their milk on foot (93.3, 100 and 100% in Mizan Aman, Debub and Shey Bench).

Table 5. Milk and milk product utilization and marketing place in the study area (n=270).

Variable	Districts		
	Mizan Aman (n=90)	Debub Bench (n=90)	Shey Bench (n=90)
	Percentage		
The utilized milk product			
Raw milk	60.0	26.7	20.0
Butter	6.6	20.0	13.3
Cottage cheese (Ayib)	10.0	20.0	26.7
Whey	-	6.7	16.7
Ergo	16.7	10.0	13.3
Butter milk (Arrera)	6.7	16.6	10.0
Means of transportation			
On foot	93.3	100	100
Bajaj*	6.7	-	-
Public transport or taxi	-	-	-
Milk marketing places			
Local market	60.0	26.7	43.3
Neighbour consumers/home	26.7	53.3	56.6
Cafeteria/hotel	10.0	3.3	-
Shop	3.3	16.7	-

n = Number of respondents; *Small vehicle which has three wheels.

Table 6. Milk marketing problem in the study area (n=270).

Problem	Districts		
	Mizan Aman (n=90)	Debub Bench (n=90)	Shey Bench (n=90)
	Percentage		
Scarcity of milk	97.8	92.2	70.0
Lack of market or collection center	1.1	3.3	15.6
Cultural restriction	1.1	4.4	14.4

n = Number of respondents.

As far as market information concerns, farmers used different sources of information for existing market prices of dairy products. About 60.0, 26.7 and 43.3% respondents get market information from market places and 26.7, 53.3 and 56.6% from neighbors in Mizan Aman, Debub and Shey Bench. A few respondents in Mizan Aman and Debub Bench get information from cafeteria and small shops/kiosks.

The study revealed that the milk production was not market oriented; most of the milk produced is retained for home consumption. The surplus is mainly processed using traditional technologies into more shelf stable products such as *Ergo* (Ethiopian naturally fermented milk), butter, ghee and *Ayib* (Ethiopian cottage cheese) that are marketed through informal channel.

The informal market involves direct delivery of fresh milk by producers to consumers in the immediate neighborhood and sale to traders or individuals in nearby towns. In the informal market, milk may pass from producers to consumers directly or it may pass through two or more market agents (NDO, 2008).

There were numerous problems related with milk marketing in the study area (Table 6). Majority of the respondents (97.8, 92.2 and 70.0% in Mizan Aman, Debub and Shey Bench) report that scarcity of milk and milk products marketing are the major problem in the study areas. In addition, some of the respondents (1.1, 3.3 and 15.6% in the Mizan Aman, Debub and Shey Bench) say absence of milk collection center or lack of proximate marketing place; while a few households said cultural restriction (1.1, 4.4 and 14.4% in Mizan Aman, Debub and Shey Bench) were the major problems. This study agreed with the report of Tesfaye (2007) that the shortage of milk (49.8%) is the main problem of milk

Table 7. The major constraints of milk production in study areas (n=270).

S/N	Major constraints	Rank
1	Shortage of feed and scarcity of land	1st
2	Disease	2nd
3	Accessibility to marketing place and limitation of market information	3rd
4	Absence of improved breed and inadequate artificial insemination	4th
5	Inadequate infrastructure	5th

marketing; while other problems like lack of access to market (21.2%), cultural restriction (20.8%) and the desire to convert whole milk into other dairy products (8.2%) are the reasons for not selling whole milk.

Constraints and opportunities of milk production

Dairy cattle milk production system was constrained by a number of factors in the study area (Table 7). The most important milk production constraints prioritized by sampled farmers were shortage of feed, scarcity of land and diseases. The other most important constraints of marketing system were accessibility to marketing place, limitation of market information, lack of improved breed and inadequate artificial insemination (AI) and inadequate infrastructure. These constraints interactively affect the performance of the genetic potential of animals leading to subsistence level of milk production.

The available opportunities of dairy development in the study area have been assessed through group discussion made with dairy producers and development agents (DAs). In the areas, many farmers have more interest on dairy production; however, the increased income from crop production would likely influence the expansion of dairy cattle production in the areas. The other future opportunities for dairy cattle production in current study areas are fast growing population and urbanization. In this regard, road construction, water supply, electrification, communication activities would favor modern dairying of remote areas. Also included are enhancing the forage production and fodder conservation in the farmers' homestead lands, formal training on artificial insemination for selected farmers at each *woreda* and strengthening the artificial insemination service at *kebele* level in man power and equipment.

CONCLUSIONS AND RECOMMENDATIONS

The results of present study showed that all the respondents were engaged in agricultural activities which are dominated by crop-livestock mixed production system. Almost all the respondents in three areas had dairy cows from 1 to 5. Smaller dairy cow holding in the current study could be justified by reduction of grazing land due to expansion of cultivation land, and population growth was forced to reduce their cattle number. All the respondents milk their cows by using hand milking either by washing cow teats or letting calf to suckle its dam for minutes to stimulate milk let-down. The types of utensils used for milking, transportation, collection and storage of milk were plastic buckets, nickel (Aluminum) and some stainless steel. The majority of the respondents did not practice recommended hygienic practices (such as hand and udder washing) during milking and further handling (processing, storage and marketing) of milk and milk products. The common milk products manufactured and utilized in this study areas include raw milk, butter, Ayib (cottage cheese), whey (Aguate), Ergo (naturally fermented milk) and buttermilk (Arrera).

The common milk production constraints in the study area were shortage of feed and scarcity of land, diseases, accessibility to marketing place, limitation of market information and inadequate infrastructure. On the other hand, the promising future opportunity for dairy development in rural areas will be fast growing population and increment of urbanization. Distinguishing the significance of dairy cattle production in the livelihood of community in the study areas, the development interventions should require boosting of production and improving milk handling practices in order to process and utilize good quality milk products. Also the improvement of infrastructure should alleviate the problem of dairy cattle milk production, handling and increase the number of marketing options which is available to smallholder farmers.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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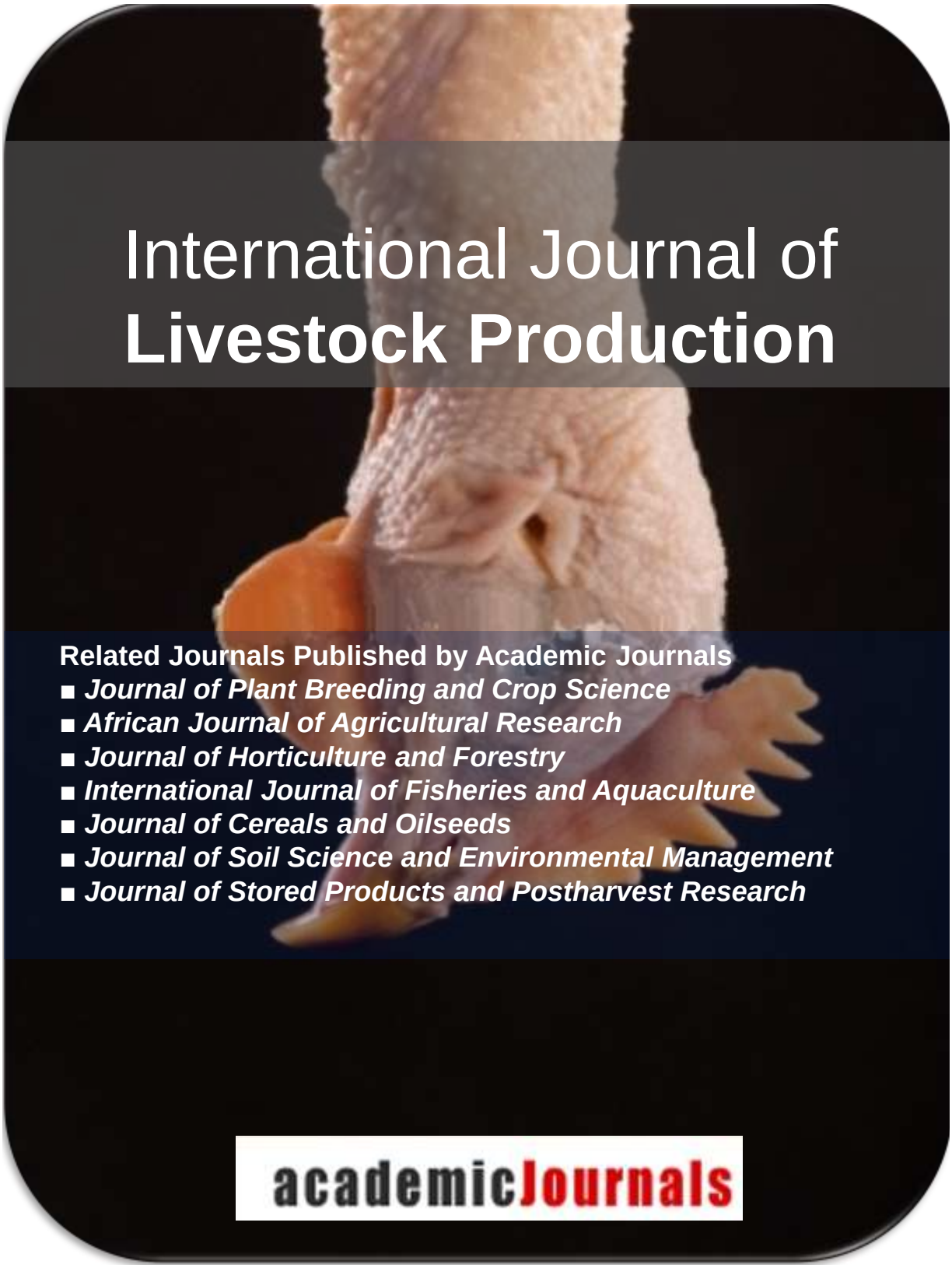

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