Indigenous Mineral Supplements of Livestock and Farmers' Perception on the Supplements in Wolaita Lowlands, Southern Ethiopia

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Abstract

The objectives of this study were to assess the indigenous sources of mineral supplements for livestock and indigenous knowledge of farmers in Wolaita lowland on the mineral supplements. A total of 180 randomly selected households from three lowland districts (Humbo, Kindo Koysha and Offa) were interviewed. Most of the respondents (78.9%) reported Addua (mineral soil) is the major indigenous mineral supplement for livestock in Wolaita lowlands whereas 19.4% of respondents reported both Addua and Yogua (mineral water) as important mineral supplements. Addua is typically offered to livestock during wet season as per 65% of the respondents. About 30.6% of the respondents indicated that Addua is offered to livestock fortnightly. Drinking Yogua is practiced in the Humbo district and mainly offered to animals at monthly interval (58.3%). According to the respondents, physiological and physical appearance such as rough hair coat (55.6%), bad smell of ruminants upon eructation (53.3%), poor appetite (48.3%) and licking of soil/old clay pots (40.6%) were reported as the major symptoms of mineral deficiency of animals perceived by farmers. On the contrary, enhanced appetite (72.8%), smooth hair coat with shining appearance (68.9%), regularity in heat/estrus (48.3%) and improved milk yield (46.1%) were observed on animals that received adequate supplementation of Addua and/or Yogua. However, laboratory analysis followed by animal experiments is required to confirm whether the indigenous mineral supplements fulfill the requirement of different species and classes of livestock.

Keywords: *Addua, Ethiopia, indigenous knowledge, lowlands, Wolaita,*

Introduction

Under grazing systems, ruminants depend on forages and drinking water to satisfy all of their nutritional requirements. Unfortunately, grazing on natural pastures often does not provide all of the needed minerals, that animals require throughout the year. Many incidences of mineral inadequacies in forages and soils have been reported which are principal causes of reproductive failure and low overall production (McDowell 1992). Kabaija and Little (1988) noted that forages from the rangeland areas in Ethiopia are deficient in several essential minerals, especially sodium (Na), phosphorus (P) and copper (Cu). Similarly, most forages and crop residues used as livestock feed in the Rift Valley areas of Ethiopia were

reported to be deficient or marginal in Na, P and Cu (Adugna and Said, 1994; Girma et al., 2000; Lemma et al., 2002). Findings of a study by Ajebu et al. (2008) indicated that some varieties of enset (*Ensete ventricosum*) in the Sidama Zone of southern Ethiopia had low Na and Cu content (except for leaf lamina).

To overcome the problem of mineral deficiencies, livestock owners in the lowlands of Ethiopia provide various types of indigenous minerals such as rock salt, mineral soils, and/or mineral water (Adugna, 2008; Temesgen and Mohammed, 2012). In Wolaita lowlands of Ethiopia, traditionally indigenous mineral supplements are widely used for different species of livestock by the local farmers (Personal communication). However, actual values of and the perception and practices of local farmers with the respect to indigenous mineral supplementation to ruminants in these areas had not been well documented except for the study by Muluken et al (2016) which was only in Humbo district. This study was conducted to investigate sources of indigenous mineral supplements, farmers' perception and practices of indigenous mineral supplementation to ruminants in Wolaita lowlands.

Materials and Methods

Descriptions of the study areas

The study was conducted in three lowland districts in the Wolaita Zone of Southern Ethiopia. The three study districts were Humbo, Offa and Kindo Koysha. Humbo district is located approximately at 6^0 34'N and 37^0 43'E latitude and longitude, respectively and at an altitude of 1100-2335 meters above sea level (masl). The mean annual rainfall of the district ranges from 840 to 1400 mm and the annual temperature ranges from 15^{o}C to 29^{o}C (HWARDO, 2014). Offa district is located at 7^O68'N and 38^O38'E latitude and longitude, respectively, with an altitude ranging from 1450 to 2800 masl. The mean annual minimum and maximum temperature of this area range between 22 to 25^{o}C, respectively. The annual rainfall ranges from 800 to 1200 mm (Abrham et al., 2012). Kindo Koysha district is located at 7°58" N latitude and 37° 56"E longitude at an altitude of 600-1700 masl. The average annual rainfall is 904 mm, the minimum and maximum daily temperature are 21 and 29.2°C, respectively (Eyasu and Ahmed, 2013). The distribution of rain fall in the study districts is bimodal, with a short rainy season from January to April and longer rainy season from June to mid-September (WZARDO, 2012).

Selection of the study districts

To select the study districts, discussions were held with Wolaita Zone Administration, livestock experts and community elders about the livestock production in the lowlands, existence and usage of indigenous sources of minerals for livestock and accessibility of the areas for the study. Furthermore, in person visits were made to the suggested districts to assess each study site. Three potential districts, Humbo, Offa and Kindo Koysha, were selected on the basis of livestock production potential, usage of indigenous sources of minerals for livestock and accessibility of the study areas. From each district three representative study sites were selected for diagnostic survey in consultation with the respective districts administrators, livestock experts, development agents and community elders.

Nature of questionnaire and data collection

In order to gather primary data on indigenous mineral sources of livestock and indigenous mineral supplementation practices, both formal and informal surveys with a single-visit multiple subject (ILCA, 1990) questionnaires were carried out following random sampling of the livestock owners who are familiar in offering indigenous mineral supplements to their livestock. A total of 180 households from three districts (60 from each districts) were participated in the interview. The interview was conducted at the farmers' residences with the assistance of district's agriculture experts with close supervision of the researchers. The selected districts agriculture experts were oriented about the objectives of the study and trained on data collection prior to commencement of the interview. In each sampling site farmers were briefed about the objective of the study before starting the interview.

Structured and semi-structured questionnaires were prepared for the survey. Beside the structured questionnaire, group discussions (with key informants from the farmers in each study sites and districts livestock experts) and personal observations were conducted during the field work. The questionnaires were designed to gather information on indigenous mineral sources and indigenous knowledge of farmers on mineral nutrition, symptoms of mineral deficiencies and perceived importance of indigenous mineral supplementation on livestock performance. To ensure the compatibility of the response from the target group with the objectives of the study, the structured questionnaires were pre-tested prior to the actual survey by interviewing ten households and the questionnaires were corrected based on the outcomes of the pre-test. During the interview, each respondent was asked to provide the estimated amount of *Addua* offered to each cattle during the feeding time and those estimated amounts of *Addua* by farmers were collected and weighed to determine the mean amount of *Addua* offered to cattle per feeding time.

Statistical analysis

Descriptive statistics such as mean, frequency, percentage, standard deviation and Chi-square test were employed to analyze the data using Statistical Package for Social Sciences version 16 (SPSS, 1996).

Results

Indigenous mineral sources and supplementation practices of farmers

Indigenous mineral sources offered to livestock in the Wolaita lowlands are presented in Table 1.

Table 1. Supplemental mineral sources (% of households) of livestock in the study districts

Mineral sources of livestock	Humbo (n=60)	Offa (n=60)	Kindo Koysha (n=60)	Overall (N=180)	$\chi 2$	*p*
Table salt	3.3	1.7	0	1.7		
Addua	38.3	98.3	100	78.9	86.897	0.000
Both Addua and *Yogua*	58.3	0	0	19.4		

n=number of respondents of each study district; N= total number of respondents of the three study districts; $\chi 2$=Chi-square.

According to the respondent, *Addua* is naturally a salty soil located in the Humbo district specifically called *Chokare* and the mineral water *Yogua* is rain water standing on *Addua*. *Addua* was the major indigenous mineral supplements of livestock followed by both *Addua* and *Yogua*. Indigenous mineral supplementation practice of farmers varied ($p<0.01$) among the study districts. Kindo Koysha farmers solely use *Addua* as a mineral supplement for livestock. Humbo farmers use *Addua, Yogua* and table salt as mineral supplements for their livestock. Offa farmers primarily used *Addua* as mineral supplement for livestock followed by table salt. However, the use of table salt as mineral supplement was very limited in all study districts.

Season and frequencies of feeding indigenous mineral supplements to livestock

Season had a significant ($P<0.01$) effect on the use of indigenous mineral supplementation (Table 2). In the study districts, majority of the farmers reported *Addua* was primarily offered to livestock during the wet season. While majority of the respondents in Offa district and some of the respondents in Kindo

Koysha district reported that they use *Addua* irrespective of any season of the year. *Yogua* was used only in the Humbo district and offered to livestock only during the wet season.

Table 2. Season of feeding indigenous mineral supplements (percent of respondents)

Season of feeding	Humbo (n=60)	Offa (n=60)	Kindo Koysha (n=60)	Overall (N=180)	$\chi 2$	*p*
Mineral soil *(Addua)*						
• Wet season	96.7	31.7	66.7	65		
• Dry season	0	0	10	3.3		
• Season independent	3.3	68.3	23.3	31.7	82.316	0.000
Mineral water (*Yogua*)						
• Wet season	95	-*	-	31.7	-	-

n=number of respondents of each study district; N= total number of respondents of the three study districts; $\chi 2$=Chi-square; *=not available.

Table 3. Frequency of offering (% respondents) *Addua* and Yogua to livestock

Variables	Humbo (n=60)	Offa (n=60)	Kindo koysha (n=60)	Overall (N=180)	$\chi 2$	p
Frequency of feeding *Addua*						
• Daily	0	38.3	1.7	13.3		
• Twice a week	0	28.3	15	14.4		
• Weekly	8.3	25	25	18.9		
• 15 days interval	46.7	6.7	38.3	30.6		
• Monthly	5	1.7	20	9.4	147.0	0.000
• Once in three months	40	0	0	13.3		
Frequency of drinking *Yogua*	n=57	n=60	n=60	N=57		
• Weekly	6.7	-	-	6.7		
• 15 days interval	18.3	-*	-	18.3		
• Monthly	58.3	-	-	58.3	-	-
• Once in three months	16.7	-	-	16.7		

n=number of respondents of each study district; N= total number of respondents of the three study districts; $\chi 2$=Chi-square; *=not available.

The majority of respondents offer *Addua* to their livestock every 15 days followed by weekly, twice a week, daily, once every three months and monthly intervals (Table 3). There was a difference among study districts in frequency ($p<0.05$) of offering *Addua* to livestock. In Humbo district, the majority of the respondents supplemented *Addua* every 15 days followed by once in three months and weekly intervals. In Offa district, daily offering of *Addua* is a common practice followed by twice a week and weekly intervals. In the case of Kindo Koysha, offering *Addua* to livestock at 15 days intervals was the most common practice followed by weekly and monthly offering intervals. Drinking *Yogua* is practiced only

in Humbo district, which usually occurs at monthly intervals followed by intervals of 15 days and once in three months.

The amount of *Addua* offered to cattle (Mean±SD) was 45.9±7.9, 22.0±11.1 and 47.8±20.4 g/head at each feeding in Humbo, Offa and Kindo Koysha districts, respectively, with a mean of 34.7 ±19.1 g/head/offering for all the three districts. Overall, the amount of *Addua* offered in the Offa district was lower ($p<0.05$) than the other two districts.

Farmers' perception of mineral deficiencies in livestock

The respondents identified several symptoms indicative of mineral deficiency in animals (Table 4).

Table 4. Mineral deficiency symptoms of animals perceived by respondents due to deficiency of *Addua* and/or *Yogua* supplementation

Category of Symptoms	Observed symptoms	Percentage of respondents					
		Humbo (n=60)	Offa (n=60)	Kindo Koysha (n=60)	Overall (N=180)	χ^2	*p*
Production and reproduction	Decrease in milk yield	0	0	26.7	8.9		
	Weight loss	21.7	30	48.3	33.3		
	Delayed heat/estrus	13.3	50	30	31.1		
Physiological and physical appearance	Bad smell upon eructation	86.7	46.7	26.7	53.3		
	Rough hair coat	30	71.7	65	55.6		
	Poor appetite	5	41.7	98.3	48.3	401.8	0.000
Behavioral changes	Licking soil/old clay pots	58.3	46.7	16.7	40.6		
	Smelling to the direction of *Addua* location	15	-	-	5		
	Sudden running of animals to *Addua* sources	43.3	-	-	14.4		
	Frequent bellowing	8.3	0	0	2.8		
State of well-being	Susceptible to disease	0	13.3	5	6.1		
	Lush pasture bloating	28.3	0	5	11.1		
	Susceptible to mange mites	8.3	61.7	41.7	37.2		
	Occurrence of worms in dung	10	5	5	6.7		

n=number of respondents of each study district; N= total number of respondents of the three study districts; χ^2=Chi-square.

These were grouped into four categories including symptoms pertaining to animal production and reproduction, physiological and physical appearance, behavior changes and state of animal well-being. Physiological and physical appearance such as rough hair coat, bad smell upon eructation, poor appetite and licking soil/old clay pots were reported as the major symptoms of mineral deficiency of animals

perceived by farmers. There was a high ($p<0.01$) perception difference among study district in identifying perceived mineral deficiency symptoms. In Humbo district, bad smell upon eructation was perceived by respondent as the major indicator of mineral deficiency followed by licking soil/old clay pots and craving of animals for *Addua*. In Offa district farmers perceived a rough hair coat as the major indicator of mineral deficiency followed by mange mites and delayed heat/estrus. Poor appetite was reported as the major indicator of mineral deficiency by Kindo Koysha respondents followed by rough hair coat and weight loss.

Farmers' perceptions on Addua supplementation on animal performances

The farmers listed the factors which they perceive are signs of animals with good mineral intake as indicated in Table 5.

Table 5. Perceived importance of *Addua* supplementation in ruminants as per the respondents

Category of changes	Perceived effects	Percentage of respondents					
		Humbo (n=60)	Offa (n=60)	Kindo-Koysha (n=60)	Overall (N=180)	$\chi 2$	*p*
Production and reproduction	Increases milk yield	36.7	43.3	58.3	46.1		
	Improves weight gain	41.7	0	88.3	43.3		
	Regular heat/estrus	51.7	46.7	46.7	48.3		
	Improves meat taste	5	0	0	1.7		
	Increases bulls sexual desire	0	0	5	1.7		
	Improves butter quality and yield	3.3	0	3.3	2.2		
	Thick milk with good smell	0	5	0	1.7	404.	0.00
Physiological and physical appearance	Increases appetite	76.7	75	66.7	72.8	4	0
	Smoothes hair coat with shining appearance	70	83.3	53.3	68.9		
	Avoids bad smell upon eructation	45	15	5	21.7		
Behavioral changes	Maintains normal behavior	0	0	28.3	9.4		
	Stops licking soil/ old pots	0	3.3	0	1.1		
State of well-being	Kills internal worms	56.7	0.0	3.3	20		
	Avoids lush feeds bloating	23.3	0	0	7.8		
	Clears digestive tract through diarrhea	8.3	0	0	2.8		
	Removes mange mites	6.7	30	13.3	16.7		

n=number of respondents of each study district; N= total number of respondents of the three study districts; $\chi 2$=Chi-square.

They reported easily observable and measurable signs through assessments. In the order of importance improved appetite, smooth hair coat with shining appearance, regular estrus cycle and improved milk yield were perceived as the major signs of animals receiving in adequate supplementation of *Addua*.

Regarding the effects of mineral supplementation on livestock, respondents from the Humbo district perceived improvement in the appetite of livestock as the first sign of optimum mineral status of the animals followed by a smooth hair coat with a shining appearance and the disappearance of internal parasites in dung. Farmers from Offa district perceived smooth hair coat with a shining appearance as the first indicator of animals with better mineral status followed by increased appetite and improved onset of estrus. In Kindo Koysha district, improved weight gain was perceived as the first sign of animals having better mineral supplementation followed by increased appetite and increased milk yields.

Discussion

Indigenous mineral sources and supplementation practices of farmers

Addua was the major indigenous source of mineral supplement in Wolaita lowlands. In similar studies different authors reported wide utilization of mineral soil for livestock. Muluken et al. (2015) reported mineral soil/ *Bole* and mineral water as sources of indigenous mineral supplements of sheep in Humbo district, Wolaita. A study conducted in Somali region of eastern Ethiopia (Sisay et al., 2007; Temesgen and Mohammed, 2012) showed that natural mineral soil known locally as Carro/ Biy'ada are found in vast area of the region and widely utilized by pastoralists. Temesgen and Mohammed (2012) reported mineral water as source of mineral supplement to camels and cattle in Jijiga district, eastern Ethiopia.

Addua is fed to livestock mainly during wet season. Farmers perceive that *Addua* is very salty and that feeding it to animals during the dry season when they do not get adequate feed and water supply could harm the animal; i.e, they think that it could cause emaciation and may ultimately kill the animals. On the contrary, the respondents perceive that feeding mineral soil during wet/rainy season when there is adequate or surplus green feed can improve feed intake, productivity and well-being of the animals. Some farmers feed *Addua* independent of the season. These farmers mostly feed *Addua* for fattening and/or milking animals that get special care and treatment than the other herds in order to consume more feed and water and produce more (weight gain or milk yield). This finding is in line with the findings of previous studies of Temesgen and Mohamed (2012) and Sisay et al. (2007). However, Muluken et al. (2015) reported that most of farmers in Humbo district feed sheep mineral soil in the dry season which contradicts with the current finding. The possible reasons for the discrepancy of the results are not clear. Among the study districts, *Yogua* (rain water standing on *Addua*) is found only in Humbo district in the wet season and farmers of the district especially in the vicinity of *Yogua* allow their animals to drink from it at monthly intervals. Majority of the farmers preferred monthly interval of drinking Yogua due to

its high salt content which could harm their animals if they drink under monthly interval. Farmers' practice of offering Yogua at monthly interval could be reasonable as Youga was high in electrical conductivity (EC), total dissolved solids (TDS), Na and potassium (K) concentration (unpublished data). According to NRC (2001) high EC and TDS in *Yogua* indicates that *Yogua* could be used with reasonable safety for adult ruminants and should be avoided for pregnant and baby calves. However, the report of offering sheep *Yogua* mainly in the dry season (Muluken et al., 2015) is also not in line to the current findings and the discrepancy of the results are not clear as from the respondents points of view and of our field observation during the dry season where we observed *Youga* got dried and not available in the dry season due to higher evaporation.

Frequency of feeding Addua and Yogua to livestock and the amount of Addua offered to cattle

Through focus group discussions farmers stated different reasons responsible for frequency of offering *Addua* to their livestock such as: 1) the effect of *Addua* on animal well-being; 2) cost of *Addua;* 3) animal numbers, and 4) the interest of the animals for *Addua.* The farmers perceived that feeding of *Addua* on at daily or weekly interval could harm/ emaciate the animals due to its salty nature. Salty nature of *Addua* could be related with high content of Na in the *Addua* (unpublished data) and also could be related with high chloride content in it. In line with farmers view, McDowell (2003) reported high intake of sodium chloride characterized by increases in water consumption, anorexia, weight loss, edema, nervousness, paralysis and a variety of signs that are dependent on the animal species involved. The farmers also indicated that feeding of *Addua* at daily or weekly intervals would be very expensive for a large number of animals due to high cost of mineral soil which is in agreement the findings of Muluken et al. (2015). Thus, as the number of animals increases, the frequency and amount of *Addua* offered decreases. Some farmers indicated that some animals are not interested in consuming *Addua* when *Addua* is offered daily. Muluken et al. (2015) reported weekly intervals of supplementation as the most common feeding frequency of mineral soil/*Bole* to sheep in the Humbo district, which contradicts with the current finding. Temesgen and Mohammed (2012) reported monthly intervals of feeding mineral soil/Biya'ada and mineral water for camels in the Jijiga district, Ethiopia.

Farmers' perception of mineral deficiency symptoms in the livestock

Farmers in the study districts are traditionally aware of the importance of mineral and lack of which could result in mineral deficiency. From their experiences, farmers related easily observable symptoms of *Addua / Yogua* deficiency. Licking soil/old clay pots observed by farmers as mineral deficiency symptom

could be associated with P deficiency in the feeds and indigenous mineral supplements in the study districts (unpublished data) which corresponds with P deficiency symptoms reported by McDowell and Valle (2000) and McDowell (2003). From the study in Somali, mineral deficiency symptoms of camel were reduced feed intake, reduced milk yield, restlessness and chewing construction/woody materials as the top symptoms of mineral deficiency listed by pastoralists (Temesgen and Mohammed, 2012). In a similar study, Rendille pastoralists in Kenya also listed inadequate rumen fill, reduced milk yield and licking of urine as the top three mineral deficiency symptoms in camels (Kaufmann, 1998; Kuria et al., 2004). Farmers/pastoralists perception of mineral deficiency symptoms more or less corresponds to scientific reports. All mineral deficiencies and most excesses, in their more severe forms, are manifested by clinical and physiological disturbances in the animal, but these are rarely specific for a single element (Underwood and Suttle, 1999). Many of the most obvious manifestations, such as subnormal growth, reduces appetite, anemia, bone abnormalities, structural defects in the skin and skeleton, impaired lactation and poor reproductive performance occur to varying degrees with deficiencies of a wide range of mineral elements (McDowell, 1992; Underwood and Suttle, 1999). In the current study, farmers reported a bad smell upon eructation as a symptom of mineral deficiency when animals are not in adequate supplementation of *Addua* and/or *Yogua* in the study districts. They also reported that supplementing animals with adequate *Addua* and/or *Yogua* avoids bad smell during eructation. In a similar study, Temesgen and Mohammed (2012) also reported perceptions of pastoralists regarding bad smell during eructation of camel can be related with mineral deficiency caused by inadequate supplementation of mineral soil lick Biya'ada. Thus, *Addua* supplementation could have effect on rumen function and manipulating the proportion of volatile fatty acids which are responsible for a bad smell upon eructation.

Farmers' perceptions on Addua supplementation effects on animal performances

Traditionally farmers assume *Addua and/or Yogua* are important to improve the well-being and productivity of animals. They also traditionally learnt from their ancestors about the importance of *Addua and/or Yogua* supplementation to their livestock. As farmers' livelihoods are directly or indirectly associated with the livestock they are interested in each observable and/or measurable changes in their livestock. In the order of importance they reported increased appetite, smooth hair coat with a shining appearance, regular onset of estrus and increased milk yield as the major perceived signs of animals in adequate supplementation of *Addua and/or Yogua*. Indigenous knowledge of farmers corresponds well to the scientific evidences of nutritional significance of mineral to the livestock. Our unpublished data showed that calcium (Ca), magnesium (Mg), Na, iron (Fe), manganese (Mn), molybdenum (Mo) and

cobalt (Co) concentrations of *Addua* were in adequate amounts according to ruminants requirements (McDowell, 2003; Puls, 1994) and *Yogua* had a good potential to contribute Na, potassium (K), P, Cu, Mo, Co and Fe for the daily requirements of the livestock in the Wolaita lowlands. Both these macro and trace elements found in the indigenous mineral supplements are vital for normal growth, milk and meat yield, reproduction, health and proper functioning of the animal's body, regulation of body fluids, transport of gases and muscle contractions, immune development, onset of estrus, better appetite and skin/wool pigmentation and pliability (McDowell 1992; Malhotra, 1998; Underwood and Suttle, 1999; Murray et al., 2000; McDowell and Valle, 2000).

Conclusion

The mineral soil locally known as *Addua* and the mineral water known as *Yogua* are the major sources of mineral supplements for livestock in Wolaita low lands. Farmers in the study districts are knowledgeable about the mineral deficiency symptoms and nutritional importance of minerals to livestock health and production, which corresponds well with scientific evidences of mineral deficiency signs and nutritional significance of minerals to livestock. Farmers also reported that *Addua* is important in reducing bad smell upon eructation which could be related with manipulation of volatile fatty acid proportion in the rumen. However, laboratory and animal experiments are required to confirm whether the indigenous mineral supplements fulfill the mineral requirements of the animals and could manipulate volatile fatty acid proportion in the rumen and reduce a bad smell of eructation in the study districts.

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