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AVAILABILITY, UTILIZATION PRACTICES AND FARMERS' PERCEPTION OF PHYTOGENIC FEED ADDITIVES FOR CHICKEN PRODUCTION IN NORTHWESTERN AMHARA, ETHIOPIA

Minichle YEGREM[1,3], Getachew ANIMUT[2], and Yeshambel MEKURIAW[1]

[1]Department of Animal sciences, Bahir Dar University, P.O. Box 5501, Bahir Dar, Ethiopia
[2]Ethiopian Agricultural Transformation Institute, P.O. Box 708, Addis Ababa, Ethiopia
[3]Department of Animal science, Debark University, P.O. Box 90, Debark, Ethiopia

Email: minichle18@gmail.com

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ABSTRACT: The study was conducted to evaluate the availability, utilization practices, and farmers' perceptions of phytogenic feed additives for chicken production in Bahir Dar city and North Gojjam zone of Amhara region. The study included three areas (Bahir Dar city, North Achefer, and Bahir Dar Zuria districts), from which 320 respondents were selected from eight Kebeles. Data were collected from farm observations, individual interviews, and focus group discussions, supplemented by secondary information from agricultural offices records, and research publications. The study revealed a total of 1625.6 Tropical Livestock Units (TLU) of chickens in the study areas, and the average chicken holding per household (HH) was 5.08 TLU. Phytogenics were used as chicken feed additives by farmers in urban, peri-urban, and rural areas, with utilization rates of 58.3, 56.3, and 52.5%, respectively. Phytogenic feed additives such as Neem (*Azadirachta indica*), Girawa (*Vernonia amygdalina*), and Nech shinkurt (*Allium sativum*) ranked 1st, 2nd, and 3rd in their availability and 1st, 3rd, and 2nd in their utilization practices, respectively. The large majority of urban and peri-urban chicken producers (70.9 and 73.8%, respectively) had awareness of phytogenic feed additive utilization practices for chicken production. Phytogenic feed additives support sustainable poultry production in Ethiopia by improving food security, public health, environmental sustainability and economic resilience. Their use supports with national development goals and key sustainable development goals (SDGs), including zero hunger, good health and well-being and climate action. This finding suggests that phytogenic feed additives are readily available and utilized in the study area for chicken production at the farmer's level, albeit with no defined doses. Further research is needed to verify the effects of these phytogenic feed additives on chicken performance, and a nationwide assessment should be conducted to quantify their potential.

Keywords: Farmer's awareness, Girawa plant, Neem, Phytogenic feed additives, Poultry nutrition.

INTRODUCTION

Feed accounts for the majority of chicken production costs. The steady increase in the cost of chicken feed ingredients and compounded formulated feed is reducing profits for chicken farmers (Thirumalaisamy et al., 2016). Numerous feed additives have been widely utilized to enhance chicken production and reduce the cost of feed. Due to their therapeutic benefits of antibiotics, these components are frequently used as additives in chicken diets (Mehdi et al., 2018). The improper use of antibiotics can lead to drug-resistant microorganisms and antibiotic residues in chicken products (Mesfin et al., 2024; Ali et al., 2025). Alternative phytogenic feed additives enhance several key processes in the chicken's body (Mandey et al., 2022). Therefore, it is essential to use phytogenic feed additives for improved and unhindered chicken production (Yitbarek, 2015).

Phytogenic feed additives are gaining interest as alternatives to conventional antibiotics, probiotics, and prebiotics, due to low costs and high productive efficacy (Jachimowicz et al., 2022; Shehata et al., 2022), as consumers may accept their inclusion in chicken diets due to their natural origin (Abou-elkhair et al., 2018). Additionally, increasing the intestinal absorption surface enhances nutrient Apparent Ileal Digestibility (AID). This improved digestion promotes the development of broilers (Ravindran and Abdollahi, 2021). Overall, phytogenic feed additives could improve feed efficiency in chicken production (Aroche et al., 2018). In Ethiopia context, traditional medicinal plants continue to play a vital role in solving livestock health challenges, including those affecting chicken (Belayneh et al., 2012). Biological activity has been documented in extracts obtained from a variety of Ethiopian local plants, including antibacterial and anti-inflammatory properties (Ayalew et al., 2022). This evidence suggests that phytogenic feed additives offer a promising pathway toward sustainable poultry production in Ethiopia. Their integration into poultry systems can contribute to multiple dimensions of development enhancing food security, protecting public health, mitigating environmental impacts, and strengthening economic resilience. Accordingly, their use aligns with Ethiopia's national development priorities and global commitments under the Sustainable Development Goals (SDGs), particularly SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), and SDG 13 (Climate Action).

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Numerous studies (Shawle et al., 2016; Asrat et al., 2018; Dolle, 2020) had focused on the effect of phytogenic feed additives on chicken production, egg quality, and growth promoters. However, researchers had not given attention to farmers' knowledge of phytogenic feed additive utilization practices and the availability of these additives.

This study provides an opportunity to understand farmers' knowledge and preferences regarding phytogenic feed additives, which is crucial for developing research and strategies to improve their utilization practices and dissemination among farmers. It is hypothesized that farmers with greater knowledge of phytogenic feed additives for chicken production are more likely to prefer these additives, perceive their availability as higher, and engage in better utilization practices. The research findings will provide important baseline data for future studies with the following objective to assess farmers' knowledge of the preference, availability, and utilization practice of phytogenic feed additives for chicken production.

MATERIALS AND METHODS

Description of study areas

The study was conducted in the urban, peri-urban, and rural study areas of Bahir Dar city and North Gojjam zone of the Amhara region. These study sites were purposefully selected based on chicken production potential; the information was obtained from the Bureau of Agricultural Offices and the CSA agricultural sample survey. Bahir Dar is the capital city of Amhara National Regional State, Ethiopia. It's located about 565 km north of Addis Ababa at 11° 38′ N latitude and 37° 10′ E longitude. The elevation of the city is about 1801 meters above sea level, and it receives an average annual rainfall of 850 mm to 1250 mm, a minimum average daily temperature of 10°C, and a maximum of 32°C. Bahir Dar Zuria District (BDZD) is found in the north Gojjam Zone. The area is located about 564 km northwest of Addis Ababa. It is situated at an altitude ranging from 1700 to 2300 metres above sea level. Its extension is between 11°25′N and 11°55′N latitude and 37°04′E-37°39′E longitude. The mean annual temperature is about 20ºC, with a maximum temperature slightly above 28.3ºC and a minimum of about 10.2ºC. The annual rainfall ranges from 800-1250 mm. North Achefer is found about a distance of 101 Km and 591 Km far from Bahir Dar and Addis Ababa respectively. Its geographical coordinates are 11° 41' 0" north latitude and 36° 57' 0" east longitude. The altitude of the district ranges from 1,500 to 2,500 m above mean sea level. North Achefer is bordered on the south by the south Achefer, on the west by the Central Gondar Zone, on the north by Lake Tana, on the east by Bahir Dar Zuria, and on the southeast by the Mecha district, and one part of the Abay River defines the district's eastern boundary, as indicated by the whole study area.

Sampling method and sample size determination

A multi-stage sampling procedure was used to collect data. Stage 1: Bahir Dar and North Gojjam zone were purposively selected based on their chicken production potential; Stage 2: Within these areas, three districts were included in the study: Bahir Dar city, North Achefer, and Bahir Dar Zuria. From these districts, three urban kebeles (two from Bahir Dar and one from North Achefer), two peri-urban kebeles from Bahir Dar, and three rural kebeles (two from Bahir Dar Zuria and one from North Achefer) were randomly selected. In the urban study areas, a list of chicken-producing households was obtained from the agricultural office. In the peri-urban and rural areas, development agents assisted in identifying households with 25 or more chickens. Finally, 40 households from each selected kebele were interviewed, resulting in a total of 320 households participating in the study. All household participants agreed to provide information and images for the study, and the individuals in the pictures consented to their inclusion in the published paper, with the understanding that these materials could be used by the researcher as needed.

Data collection

Respondents' ranked major phytogenic feed additive sources for chickens based on their preferences and perceived effectiveness during utilization. A focus group discussion with community members in the study areas gathered information on utilization techniques and parts used for these additives. Additionally, semi-structured interviews were conducted with key informants including elders, long-time chicken farmers, and a veterinarian with experience in chicken farming to assess the availability and utilization practices of phytogenic feed additives. Both primary and secondary data were collected from various sources.

Conversion factor of livestock population (TLU)

Data on the livestock population in the sampled households were obtained from the interview of household heads during the survey. The number of livestock population was converted into tropical livestock unit (TLU) using the conversion factors of camel (1), cattle (0.7), sheep (0.1), goat (0.1), mules (0.7), horses (0.8), donkeys (0.5), and poultry (0.01) (Varvikko et al., 1993).

Sampling procedure for phytogenic additives

The questionnaires addressed farmers' perceptions of phytogenic feed additive utilization and availability. Following an assessment of available phytogenic feed additive resources, the top five additives were selected for chemical analysis. These major phytogenic feed additives were selected based on availability and farmer preferences. Samples of these additives were collected from the study areas to determine their chemical composition.

Proximate chemical analysis for selected phytogenic additive

The identified top 5 phytogenic feed additives were selected based on rank results. The leaf part of neem, Girawa and Tiql Gomen; the bulb part of Nech shinkurt and the rhizome of Zingible were collected in Bahir Dar and around Bahir Dar. The samples were ground into powder by using a hammer mill to pass through a 1 mm screen for chemical analysis. The samples of phytogenic feed additives were sent to the Animal nutrition laboratory of Jimma University for chemical analysis. The DM content of feed samples was determined by drying them in an oven at 105°C overnight (AOAC, 2000). Ash was determined by the complete burning of the sample at 550°C for 5 hours in a muffle furnace. Nitrogen (N) was determined using the Kjeldjhal method and then the crude protein calculates as N× 6.25 (AOAC, 1995). Crude fiber contents were analyzed using (AOAC, 1990) method. Total phosphorus contents were determined by the Vanado-Molybdate method (AOAC, 2000). The metabolizable energy (ME) was estimated according to the equation proposed by Wiseman (1987); ME (kcal/kg) = 3951 + 54.40 fat-88.70 ash. Nitrogen-free extract (NFE) was calculated by the difference between organic matter and the sum of ash, CF, EE, and CP.

Survey data management and statistical analysis

The collected data from the survey of urban, peri-urban and rural areas were entered into *the Statistical Package* for Social Sciences (SPSS version 27) software. The normality of the data was tested using the Kolmogorov-Smirnov Test. Chi-square was employed for the association of such parameters between urban, peri-urban and rural. Descriptive statistics were used to analyze the mean values of the quantitative data frequencies and percentages values. Means of quantitative data between urban, peri-urban and rural study areas were compared by employing analysis of variance (ANOVA). Means were separated using the Tukey test at P<0.05 significant level. The statistical model was used: $Y_{ij}=\mu + \alpha_i + \Sigma_{ij}$

Where: y_{ij} = is the response variable; μ = is the overall mean; α_i = the effect of i^{th} locations (urban, peri-urban and rural areas); Σ_{ij} = random error

Priority index was employed using the following formula (Kosgey, 2004).

$$Index = \frac{\Sigma\ (\text{n x No. of HHs ranked 1st}) +\ (\text{n}-1)\text{x No. of HHs ranked 2nd}\ ) + \cdots +\ 1\text{ x No. of HHs ranked last}) \text{ for one factor}}{\Sigma\ (\text{n x No. of HHs ranked 1st} +\ (\text{n}-1)\text{x No. of HHs ranked 2nd} + \cdots . +1\text{x No. of HHs ranked last})\text{for all factors}}$$

Where; n: value given for the least ranked level (example if the least rank is 5th rank n-1=4, n-2=3 and.........n=1)

RESULTS AND DISCUSSIONS

Socioeconomic characteristics of the respondents

Table 1 presents the characteristics of households in the study areas. Age had a significant effect (P < 0.05) on chicken farming in the study areas. The average ages of respondents were 31.25 years in urban areas, 37.63 years in peri-urban areas, and 43.33 years in rural areas. This indicates an active working force with the potential for a positive effect on livestock development. The average family size was 3.83 people per household in urban areas, 6.25 in peri-urban areas, and 5.68 in rural areas, resulting in an overall average of 5.3 people per household. This result is comparable to Addis and Malede (2014), who reported an average family size of 5.7 in the Quara district. Significant differences (p < 0.05) in family size were observed across the study areas, which might be attributed to variations in family planning programs between urban, peri-urban, and rural communities. The majority of respondents were female household heads: 61.7% in urban areas, 67.7% in peri-urban areas, and 60% in rural areas. This suggests that women play a significant role in chicken production. There were significant differences (P < 0.05) in marital status across the study areas. 83.3% of households in rural areas, 77.5% in peri-urban areas, and 81.7% in urban areas had married household heads. Educational background also showed significant differences (P < 0.05) across the study areas. Illiterate households comprised 3.3% in urban areas, 42.5% in peri-urban areas, and 43.3% in rural areas. While 60% of urban households had a certificate or higher qualification, no households in peri-urban or rural areas held such credentials. This higher proportion of educated individuals in urban areas might contribute to the favorable acceptance of technologies like phytogenic feed additives and increased awareness about their use for improving chicken performance.

Livestock holding and composition

The average number of livestock held per household in the study area is shown in Table 2. The mean number of livestock per household in rural study areas was 4.13 heads of cattle, 0.61 heads of sheep, 0.12 heads of goats, 0.30 heads of donkey, 0.10 heads of mule, and 0.28 heads of chicken. In the peri-urban study area, the mean number of livestock per household was 3.85 heads of cattle, 0.67 heads of sheep, 0.13 heads of goats, 0.78 heads of donkey, 0.12 heads of mule, and 0.26 heads of chicken. However, livestock producers in urban study areas primarily raised cattle and chickens, with an average of 0.19 heads of cattle and 14.71 heads of chicken per household. In terms of Tropical Livestock Units (TLU), the average livestock ownership was 8.75, which differed significantly (P < 0.05) across study areas. However, urban study areas had a significantly higher average chicken keeping rate (14.71, P < 0.001) compared to peri-urban (0.26) and rural areas (0.28). Chicken accounted for the largest portion of the total livestock number in the sampled households in urban areas. This is due to population growth, rising individual consumption, and the expansion of hotels, which have led to a higher demand for chicken meat and eggs in urban areas compared to peri-urban and rural study areas.

Table 1 - Demographic and socioeconomic characteristics of the sampled households.

Parameters \ Study areas		Urban	Peri-urban	Rural	X^2	P-value
Age of HH heads (years)		31.25	37.63	43.33	148.97	***
Family size of HH heads (No.)		3.83	6.25	5.68	125.9	***
Sex of HH heads (%)	Male	38.3	32.5	45	3.23	ns
	Female	61.7	67.5	55		
Marital status (%)	Single	13.3	12.5	3.3	26.8	***
	Married	81.7	77.5	83.3		
	Widow	5	10	5		
	Divorced	0	0	8.3		
Educational level (%)	Illiterate	3.3	42.5	43.3	187.9	***
	Elementary	26.7	21.3	29.2		
	Secondary	3.3	17.5	19.2		
	Preparatory	5	6.3	2.5		
	Certificate and above	60	0	0		
	Religious	1.7	12.5	5.8		

HH= household, ns = non-significant, sig= significant value, X^2 =chi square, ***= significant at p< 0.001

Table 2 - The mean of livestock composition per household in the study areas in terms of TLU.

Livestock type \ Total livestock in TLU	Urban	Peri-urban	Rural	SEM	P-value
Cattle	0.19^b	3.85^a	4.13^a	0.042	***
Goat	-	0.13^a	0.12^a	0.004	ns
Sheep	-	0.67^a	0.61^a	0.011	ns
Donkey	-	0.78^a	0.30^b	0.010	***
Mule	-	0.12^a	0.10^a	0.004	ns
Chicken	14.71^a	0.26^b	0.28^b	0.213	***
Total	14.9	5.81	5.54	-	-

SEM= standard error of mean, ns = non-significant, ***= significant at p< 0.001

Type of additives and purpose of feeding for chickens

Table 3 presents the types of feed additives used in the study areas. In urban areas, 59.2% of respondents reported using both antibiotics and phytogenic feed additives. A smaller proportion (5.6%) used only phytogenic feed additives, while 35.2% used only antibiotics. Additionally, 4.3% of respondents in urban areas reported using both phytogenic and antibiotic feed additives. In contrast, peri-urban and rural respondents primarily relied on phytogenic feed additives, with 91.5% and 87.3% of respondents, respectively, using them. In peri-urban areas, 4.3% of respondents used only antibiotics, and 12.7% used both phytogenic and antibiotic feed additives in rural areas. The majority of respondents in urban areas (70.4%) used feed additives for improving chicken productivity, egg quality, growth, and health. In contrast, only 4.3% and 6.3% of peri-urban and rural respondents, respectively, reported using phytogenic feed additives for these purposes. Urban respondents were less likely to use feed additives for chicken treatments (9.3%) compared to peri-urban (95.7%) and rural (92.1%) respondents. A small percentage of urban respondents (7.4% and 3.7%, respectively) reported using feed additives for egg production and quality improvement. This was significantly lower than the 1.6% of rural respondents who used feed additives for this purpose. A significant proportion of respondents in all study areas reported never using phytogenic feed additives: 41.7% in urban areas, 43.8% in peri-urban areas, and 47.5% in rural areas. The primary reason cited for non-use was a lack of knowledge about phytogenic feed additives, their utilization practices, and their importance. Farmers primarily cultivate spices for human consumption and income, rather than for animal feed.

Sources of chicken feed additives in study areas

Figure 1 illustrates the sources of chicken feed additives in urban, peri-urban, and rural study areas. Backyard sources were the primary source of feed additives in peri-urban and rural areas, accounting for 22.2% and 72.2% of sources, respectively. In urban areas, both backyard and commercial sources were used, with 39.5% sourced from backyards and 36.3% from commercial suppliers. The high reliance on backyard sources in rural areas highlights the significant role of backyard cultivation of phytogenic feed additives within these communities. This reliance on backyard sources could be attributed to a decline in wild plant resources due to deforestation and lack of conservation, particularly for medicinal plants and herbs in the study area communities. This observation contradicts the findings of Regassa (2013) and Fenetahun et al. (2017), who reported that over 70% and 50% of medicinal plants, respectively, were collected from wild habitats.

Table 3 - Types and Purpose of feeding the feed additives in study areas.

Type of feed additives supplementation		Urban		Peri-urban		Rural		X²
		N	%	N	%	N	%	
Did you provide any feed additives for your chickens?	Yes	108	90	47	58.8	63	52.5	43.17***
	No	12	10	33	41.3	57	47.5	
Did you provide phytogenic feed additives for your chicken?	Yes	70	58.3	45	56.3	63	52.5	0.84 ns
	No	50	41.7	35	43.8	57	47.5	
Antibiotics		38	35.2	2	4.3	-	-	
Phytogenic feed additives		6	5.6	43	91.5	55	87.3	154.11***
Both phytogenic and antibiotics feed additives		64	59.3	2	4.3	8	12.7	
Purpose of offering feed additives for chicken								
Production improvement		8	7.4	-	-	-	-	
Quality improvement		4	3.7	-	-	-	-	
For treatment (medicine)		10	9.3	45	95.7	58	92.1	156***
For production, quality, growth, and treatment		76	70.4	2	4.3	4	6.3	
Production and quality improvement		8	7.4	-	-	1	1.6	
Increase growth		2	1.9	-	-	-	-	

N = frequency, X^2 =chi square, ***=significant $p \leq 0.001$, **= $p \leq 0.01$

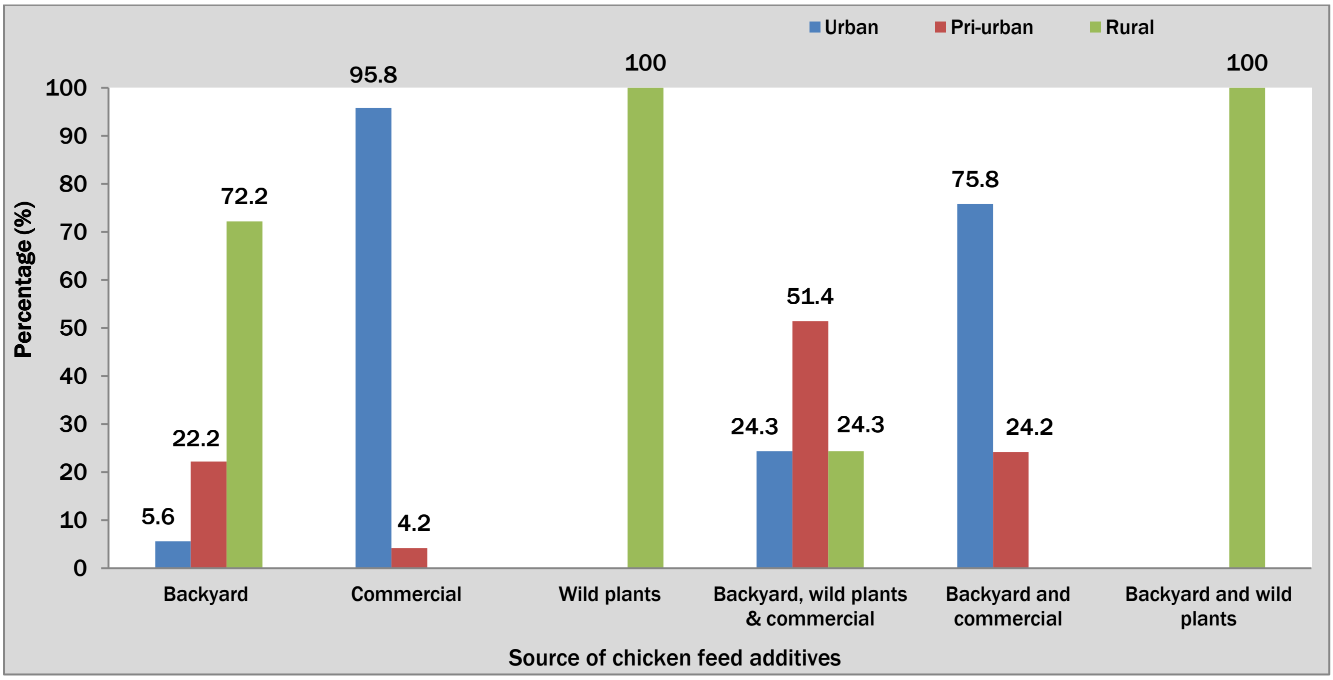

Figure 1 - Different sources of chicken feed additives in the study areas.

Availability of phytogenic feed additives in study areas

Table 4 presents the major phytogenic feed additive resources available in the study areas. The most dominant phytogenic additives, based on their availability, were Neem, Girawa, Nech Shinkurt, Tiql Gomen, Gomen, Berbere, Fenugreek, Zingible, Lomi, Tiqur Azimud, and Qariya. Other additives were available to a lesser extent. Except for Neem, Simiza, Girawa, and Damakasie, the other additives in urban study areas were purchased from the market. Their availability and affordability influenced their ranking. Neem was the top-ranked phytogenic feed additive source for chickens in urban and rural areas, and the 4th ranked source in peri-urban areas. It is available year-round in its green form. Zingible, Girawa, Nech shinkurt, and Tiql Gomen were among the top-ranked phytogenic feed additives, ranking 2nd, 3rd, 4th, and 5th in urban areas and 3rd, 1st, 2nd, and 5th in peri-urban areas, respectively. Yetibs Qtel, Tsosign, and Sinafch were not available in peri-urban and rural study areas. Respondents used spices such as Abish, Tiqur azmud, Berbere, and Feto due to their longer shelf life and availability during the dry season. Processing techniques for preserving other perishable phytogenic feed additives were not widely adopted. Feto (*Lepidium sativum*) was highly valued in peri-urban and rural areas for its medicinal properties but was scarce due to its limited occurrence and distribution. Herbicide use in other crops has also contributed to its decline.

Utilization practices and preferences of phytogenic feed additives for chickens

Table 5 presents the most preferred phytogenic feed additives in the study areas, including Neem, Nech Shinkurt, Girawa, Tiql Gommen, Zingible, Simiza, Sinafich, Feto, and others. Farmers ranked these additives based on their perceived effectiveness in enhancing chicken production, product quality, and health, reflecting the criteria they prioritize in their actual usage. Girawa ranked 1st in rural areas, 2nd in urban areas and 3rd in peri-urban areas. It was primarily used to treat chickens and improve egg quality. Neem was ranked 1st for egg production, quality improvement, and health care in urban and peri-urban areas and 2nd in rural areas. Farmers primarily used neem to treat sick chickens. Garlic (Nech shinkurt) was ranked 3rd in urban areas, 2nd in peri-urban areas, and 3rd in rural areas. Overall, it was ranked 2nd in the production system and used for improving chicken performance. The preference for phytogenic feed additives is attributed to a combination of factors: They are readily available, low Cost and practical applicability

Perception of farmers towards phytogenic feed additives

The majority of respondents reported using phytogenic feed additives for their chickens (Table 6). Awareness of their use varied across study areas: 40% of respondents in urban areas, 60% in peri-urban areas, and 33.3% in rural areas were aware of their use as treatments. Notably, 21.7% of rural farmers recognized their use for preventing several chicken diseases. Respondents consistently highlighted the significant role of phytogenic feed additives in treating sick birds. This finding suggests that many farmers in peri-urban and rural areas utilize spices and medicinal plants to maintain their chickens' health. While awareness of using phytogenic additives for improving chicken product quality and production was lower, some respondents shared insights. Only 8.8% and 5% of respondents in peri-urban areas, and 2.5% and 1.7% in rural areas were aware of this application, respectively. However, these respondents provided anecdotal evidence: they observed that older chickens' eggshells softened, but feeding them neem leaves resulted in thicker eggshells and a more yellowish yolk. This suggests a potential connection to the carotenoid compounds and calcium content in neem leaves. In urban study areas, 19.17% and 6.67% of respondents used phytogenic feed additives to enhance chicken quality and production, respectively. Furthermore, 5% of respondents in urban areas expressed a favorable view of phytogenic feed additives as an alternative to antibiotics. However, a significant portion of respondents (29.2% in urban, 26.3% in peri-urban and 40.8% in rural study areas) lacked awareness of the full benefits of phytogenic feed additives. This was particularly evident in peri-urban and rural areas, where almost all farmers lacked knowledge about using phytogenic feed additives to improve chicken product quality and production.

Table 4 - The available phytogenic feed additive resources in the study areas.

Phytogenic feed additives		Urban		Peri-Urban		Rural		Overall	
Local name	Scientific name	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Neem	*Azadirachta indica*	0.0708	1	0.086	4	0.124	2	0.09	1
Ginger	*Zingiber officinale*	0.069	2	0.087	3	0.049	11	0.056	9
Girawa	*Vernonia amygdalina*	0.068	3	0.11	1	0.135	1	0.088	2
Nech shinkurt	*Allium sativum*	0.067	4	0.105	2	0.073	3	0.071	3
Tiql gomen	*Brassica oleracea*	0.063	5	0.065	5	0.0547	10	0.0708	4
Gomen	*Brassica carinata*	0.06	6	0.055	10	0.0657	7	0.0698	5
Qariya	*Capsicum annuum L*	0.059	7	0.044	13	0.017	16	0.051	11
Abish	*Trigenella foenum-graecum*	0.057	8	0.026	16	0.004	20	0.062	8
Berbere	*Capsicum frutescens*	0.0568	9	0.06	6	0.066	6	0.068	6
Tiqur azimud	*Nigella sativa*	0.056	10	0.049	12	0.056	8	0.0498	12
Lomi	*Citrus aurantiifolia*	0.055	11	0.05	11	0.0697	4	0.0529	10
Tena adam	*Ruta chalepensis*	0.053	12	0.044	13	0.039	13	0.0496	13
Tomato	*Lycopersicon esculentum*	0.05	13	0.0566	9	0.0678	5	0.063	7
Qey shinkurt	*Allium cepa*	0.049	14	0.034	15	0.029	14	0.038	14
Feto	*Lepidium sativum*	0.043	15	0.059	7	0.047	12	0.028	15
Simiza	*Justicia schimperiana*	0.041	16	0.012	17	0.0177	15	0.025	16
Endod	*Phytolacca dodecandra*	-	-	-	-	0.009	18	0.014	19
Tosign	*Thymus schimperi*	0.0275	17	-	-	-	-	0.024	17
Sinafich	*Sinapis alba*	0.027	18	-	-	-	-	0.015	18
Yetbs Qtel	*Rosmarinus officinalis*	0.025	19	-	-	-	-	0.0069	20
Damakase	*Ocimum urticifolium*	0.0008	20	0.057	8	0.0555	9	0.0051	21
Eret	*Aloe adigratana*	-	-	-	-	0.0045	19	0.0012	23
Serkabeba	*Senna didymobotrya*	-	-	-	-	0.0128	17	0.0017	22
Nech bahir zaf	*Eucalyptus globulus*	-	-	-	-	0.0033	21	0.0006	24

Table 5 - Utilization practice and preference of phytogenic feed additives ranked by respondents.

Phytogenic feed additives		Urban		Peri-urban		Rural		Overall	
Local name	Scientific name	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Neem	*Azadirachta indica*	0.27	1	0.157	1	0.125	2	0.1	1
Girawa	*Vernonia amygdalina*	0.16	2	0.142	3	0.130	1	0.086	3
Nech shinkurt	*Allium sativum*	0.14	3	0.148	2	0.100	3	0.0865	2
Tiql Gomen	*Brassica oleracea*	0.13	4	0.117	4	0.057	8	0.08	4
Zingible	*Zingiber officinale*	0.07	5	0.116	5	0.081	4	0.075	5
Sinafich	*Sinapis alba*	0.06	6	-	-	-	-	0.062	8
Feto	*Lepidium sativum*	0.05	7	0.104	6	0.073	6	0.057	9
Tiqur azmud	*Nigella sativa*	0.045	8	0.025	11	0.043	11	0.042	11
Qariya	*Capsicum annuum L.*	0.03	9	0.036	8	0.013	17	0.0386	14
Berberie	*Capsicum frutescens*	0.016	10	0.035	9	0.019	15	0.0387	13
Qey shinkurt	*Allium cepa*	0.015	11	0.009	13	0.032	13	0.072	6
Tomato	*Lycopersicon esculentum*	0.01	12	0.01	12	0.020	14	0.041	12
Simiza	*Justicia schimperiana*	-	-	0.088	7	0.066	7	0.066	7
Damakase	*Ocimum urticifolium*	-	-	0.026	10	0.011	18	0.052	10
Nech Bahir zaf	*Eucalyptus globulus*	-	-	-	-	0.014	16	0.017	17
Endod	*Phytolacca dodecandra*	-	-	-	-	0.036	12	0.0168	18
Serkabeba	*Senna didymobotrya*	-	-	-	-	0.075	5	0.033	15
Tena adam	*Ruta chalepensis*	-	-	-	-	0.050	10	0.024	16
Eret	*Aloe adigratana*	-	-	-	-	0.055	9	0.014	19

Table 6 - Farmers' attitude and awareness of phytogenic feed additives

Parameters	Description of phytogenic feed additives importance for chicken	Study areas						X^2
		Urban (%)		Peri-urban		Rural		
		N	%	N	%	N	(%)	
Knowledge	Awareness of product quality improvement	23	19.2	7	8.8	3	2.5	85.47**
	Having an awareness of production improvement	8	6.7	4	5	2	1.7	
	Aware that used as chicken treatments	48	40	48	60	40	33.3	
	No aware of phytogenic feed additives	35	29.2	21	26.3	49	40.8	
Attitude	Used as a good alternative to antibiotics	6	5	-	-	-	-	78.56**
	Aware that phytogenic additives can be used as a prevention	-	-	-	-	26	21.7	

N=frequency, X^2= chi-square, **=significant at p<0.01

Utilization techniques and parts used of phytogenic feed additives in study areas

Farmers agreed on the utilization techniques and plant parts used for chickens during group discussions in each production system (Table 7). The most common technique involved crushing and chopping phytogenic additives into small pieces, soaking them in water, and providing this mixture as drinking water. This prevalent use of water likely relates to its ability to dissolve many active compounds. In rural areas, specific phytogenic plants are commonly used to treat Newcastle disease: Feto (*Lepidium sativum*), simiza, Eret, Nech bahir zaf, Girawa, and Nech shinkurt, often mixed with drinking water and Injera Fitfit. Crushing and chopping techniques are frequently employed to extract bioactive components from plant parts, providing an immediate response to diseases and aiding in recovery. Leaves are the most commonly used part, followed by seeds (Table 7). This aligns with previous research suggesting leaves are more widely used due to their greater availability and ease of processing, as well as their richness in secondary metabolites (Nigussie et al., 2018). However, this contrasts with Atagal (2015) study in Uganda, where roots were the most frequently used part. Similar findings were observed in other Ethiopian regions, where roots were the most commonly harvested plant part (Birhane et al., 2011; Mengistu et al., 2017).

Table 7 - List of phytogenic feed additives identified processing methods in the study areas

Local name	Plant scientific name	Part used	Method of processing	Utilization techniques of phytogenic feed additives	Role phytogenic additives for chicken in study areas
Neem	*Azadirachta indica*	Leaf	Chopped & crushed, as it is	Crushed & Chopped neem leaf soaked with water then the juice mixed with Injera & other feed or hinging neem leaf in the chicken house for direct fed	Disease treatment and prevention, egg yolk and shell improvement
Nech shinkurt	*Allium sativum*	Bulb	Crushed and chopped	Added into chicken drinking water or mixed with Injera Fitfit or other feed	Disease treatment
Zingible	*Zingiber officinale*	Rhizome	Crushed and chopped	Added into chicken drinking water	Disease treatment
Girawa	*Vernonia amygdalina*	Leaf	Crushed, rubbed & as it is	Crushed & rubbed Girawa leaf by soaking with water then the juice mixed with injera & other feed	Disease treatment
Abish	*Trigenella foenum-graecum*	Seed	Grinded and crushed	Mixed with other feed and added into drinking water	Disease treatment
Qariya		Fruit	Chopped, as it is	Direct to fed or the chopped fruit soaked with water then added into drinking water	Disease treatment
Yetbs Qtel	*Rosmarinus officinalis*	Leaf	Rubbed and as it is	The rubbed leaf of *Rosmarinus officinalis* direct fed or mixed with other feed	Disease treatment
Feto	*Lepidium sativum*	Seed	Ground and crushed	Ground and crushed Feto mixed with Injera Fitfit or added into drinking water	Disease treatment & prevention
Tena Adam	*Ruta chalepensis*	Leave and young stem	Crushed, soaked, as it is	Crushed part of Tena Adam added into drinking water	Disease treatment & prevention
Berberie	*Capsicum annuum L.*	Fruit pulp	Grinded	Berbere powder mixed with oil and then added to other feed or chicken drinking water	Disease treatment
Gomen	*Brassica carinata*	Leaf and seed	Crushed, chopped and grinded	The powder mixed with feed or water which was given to sick chicken and chopping leaf used as it is for chicken feed	Disease treatment & egg yolk improvement
Lomi	*Citrus aurantiifolia*	The liquid in the fruit	Sliced	Slicing then Squeezing it to produce juice and added it to chicken drinking water	Disease treatment
Tiql Gomen	*Brassica oleracea*	Leaf	Chopped and chopped	Chopping it and as it is to provide it for chicken	Disease treatment & egg yolk improvement
Senafch	*Sinapis alba*	Seed	Crushed and grinding	The powder mixed with feed or water which was given to sick chicken	Disease treatment
Damakase	*Ocimum urticifolium*	Leaf	Rubbed, soaked	rubbed the leaf and add water to produce leaf juice then added to drinking water and mixed with Injera	Disease treatment
Simiza	*Justicia schimperiana*	Leaf	Chopped & rubbed, soaked	Chopped leaf and rubbed with water then added into drinking water or mixed with Injera Fitfit	Disease treatment
Nech bahir zaf	*Eucalyptus globulus*	Leaf	Crushed, chopped & rubbed	Processed leaf soaked with water then added to the chicken drinking water or leaf juice mixed with Injera Fitfit	Disease treatment
Endod	*Phytolacca dodecandra*	Leaf	Crushed	The crushed leaf is soaked with water and then filter the leaf juice and added to the drinking water	Disease treatment
Serkabeba	*Senna didymobotrya*	Leaf	Chopped & rubbed, soaked	The chopped leaf rubbed with water then filter the leaf juice and added to the drinking water	Disease treatment
Eret	*Aloe adigratana*	Leaf	Chopped & crushed	The jelly juice of Eret is added into drinking water or mixed with injera	Disease treatment

Phytogenic feed additive processing techniques and feeding frequency

The respondents employed diverse processing methods for phytogenic feed additives, as shown in Table 8. A significant difference (P < 0.05) in processing methods was observed between study areas. Crushing, chopping, soaking, and grinding were the most common preparation methods used. Crushing was the predominant method in urban areas (41.4%), next to peri-urban areas (48.9%). In rural areas, a combination of chopping and crushing was most common (34.9%). These findings align with Fenetahun et al. (2017) who, study that identified crushing (53.70%), squeezing (25.93%), chewing (16.67%), and cooking (3.70%) as the primary processing methods for remedies. The chopping method was used by 20% of respondents in urban areas, 35.6% in peri-urban areas, and 9.6% in rural areas. Soaking was employed by 14.3% in urban areas, 13.3% in peri-urban areas, and 12% in rural areas. While 10% of urban respondents used phytogenic feed additives without processing, only 2.2% in peri-urban and 1.6% in rural areas did the same. Grinding was used by 14.3% of urban respondents, but not by any respondents in peri-urban or rural areas. The frequency of phytogenic feed additive provision to chickens also varied significantly (P < 0.05) between study areas. The majority of respondents (80% and 68.3%) in peri-urban and rural areas, respectively, provided phytogenic feed additives when the chickens became sick. In urban areas, 28.6% of producers offered phytogenic feed additives once daily after providing a standard diet. Another 31.7% of rural producers provided phytogenic feed additives during disease outbreaks on neighboring farms to prevent disease. Only 5.7% of urban respondents provided phytogenic feed additives twice daily after provide standard diet. A small percentage of urban respondents (11.4%) provided phytogenic feed additives three times daily and 11.4% also provided them when the chickens became sick.

Table 8 - Processing techniques and feeding frequency of phytogenic feed additives

Phytogenic feed additives processing techniques	Urban		Peri-urban		Rural		X^2
	N	%	N	%	N	%	
Chopping	14	20.0	16	35.6	6	9.5	92.58***
Soaking	10	14.3	6	13.3	8	12	
As it is	7	10.0	1	2.2	1	1.6	
Griding	10	14.3	-	-	-	-	
Crushing	29	41.4	22	48.9	16	25.4	
Chopped and rubbed	-	-	-	-	8	12.7%	
Sliced and rubbed	-	-	-	-	2	3.2%	
Chopped and crushed	-	-	-	-	22	34.9%	
Providing frequency of phytogenic feed additives							
One time per day	20	28.6	-	-	-	-	157***
Two times per day	4	5.7	-	-	-	-	
Three times per day	8	11.4	-	-	-	-	
Some times	12	17.1	-	-	-	-	
Once a week	4	5.7	-	-	-	-	
Three times a week	14	20.0	9	20	-	-	
When chickens become sick	8	11.4	36	80	43	68.3	
Disease occurrences in neighbor farm	-	-	-	-	20	31.7	

N = frequency, X^2 =chi square, ***=significant at $p \leq 0.001$

Utilization constraints of phytogenic feed additive

Table 9 presents the constraints hindering the utilization practices of phytogenic feed additives. A significant difference (P < 0.05) in these constraints was observed across study areas. The most frequently reported constraint was a lack of knowledge about the importance of phytogenic feed additives, mentioned by 41.7% of respondents in urban areas, 50% in peri-urban areas, and 43.3% in rural areas. While development agents and other stakeholders have conducted awareness-raising activities about using leafy greens as sources of protein and vitamins, information about the use of spices and medicinal plants to improve chicken production and product quality remains limited. In urban areas, 18.3% of respondents mentioned the high cost of certain spices as a challenge to their use as chicken feed additives.

Chemical composition of major phytogenic feed additives

Table 10 shows the chemical compositions of the top five ranked phytogenic feed additives. The current study found that *Azadirachta indica* contained 90.62% DM, 18.11% ash, 3.40% EE, 7.54% CF, 16.78% CP, 0.095 mg/g P, and 44.79% NFE. These values are lower than those reported by Bonsu et al. (2012) for CP, CF, EE, ash, moisture, and NFE, but higher for ash, CP, DM, and EE. The ash, DM, EE, and CF contents also differed from those reported by Ubua et al. (2019). These variations in chemical composition likely stem from factors such as the type of *Azadirachta indica* tree, the age of the leaves, the location, the season of harvest, the soil type, and the processing method used. The ash content of *Vernonia amygdalina* in the current study (16.29%) was higher than the value reported by Asaolu et al. (2012) for bitter leaf (9.56%). Ash content is an indicator of mineral element presence. The protein content of *Zingiber officinale* in the current proximate analysis (9.68% CP) is comparable to (Dolle, 2020) findings, but higher than the values reported by Otunola et al. (2010) (8.54% CP) and Onimawo et al. (2019) (8.91% CP).

Table 9 - The major constraint of phytogenic feed additives utilization in the study areas

Phytogenic feed additives processing techniques	Urban		Peri-urban		Rural		X^2
	N	%	N	%	N	%	
Lack of knowledge about the level of inclusion	26	21.7	28	35	36	30	44.39***
High prices of some types of spices additives	22	18.3	-	-	-	-	
Lack of extension worker advice	22	18.3	12	15	32	26.7	
Lack of knowledge about the importance	50	41.7	40	50	52	43.3	

N = frequency, X^2 =chi square, ***=significant at $P \leq 0.001$

Table 10 - Chemical composition of the first five ranked phytogenic feed additives

Parameters / Phytogenic feed additives	*Azadirachta indica*	*Allium sativum*	*Brassica oleracea*	*Vernonia amygdalina*	*Zingiber officinale*
DM, %	90.62	90.78	87.3	93.28	89.87
Ash, %	18.11	20.07	18.95	16.29	15.85
EE, %	3.4	3.46	3.53	3.6	3.66
CF, %	7.54	7.89	8.08	8.01	7.81
CP, %	16.78	11.38	12.26	22.62	11.08
P (mg/g)	0.095	0.079	0.081	0.096	0.088
OM, %	81.89	79.93	81.05	83.71	84.15
NFE, %	44.79	47.98	44.48	42.76	51.47
ME (Kcal/kg DM)	2728.27	2620.53	2653.18	2771.72	2810.68

DM: dry matter; EE: Ether extract; CF: crude fiber; CP: crude protein; P: phosphorus; OM: organic matter; NFE: nitrogen free extract; ME: Metabolizable energy.

CONCLUSIONS

The study found that chicken feed additives primarily come from backyard plants, wild plants, and commercial antibiotics. In peri-urban and rural areas, there is limited awareness of using phytogenic feed additives (plant-based additives) to improve chicken performance, rather than just for health benefits. The use of these additives is influenced by their potential to improve human food, generate income, or both. Farmers tend to select phytogenic additives based on their effectiveness in improving chicken health, production, and product quality. Based on farmers' rankings across different study areas, the top three most preferred phytogenic feed additives were *Neem*, *Girawa*, and *Nech Shinkurt*. *Girawa* emerged as the most consistently valued plant, ranking first in rural areas and among the top three in urban and peri-urban settings. These plants were primarily selected for their perceived effectiveness in improving chicken health, and supporting overall poultry productivity. This approach aligns with key Sustainable Development Goals: SDG 2 (Zero Hunger) by contributing to improved poultry productivity and food security; SDG 3 (Good Health and Well-being) by offering natural alternatives to antibiotics, thereby reducing the risks associated with antibiotic resistance; and SDG 13 (Climate Action) by helping reduce environmental impacts such as ammonia (NH_3) gas emissions from chicken farms through the use of phytogenic feed additives. Key challenges for producers include a lack of knowledge about proper usage, limited guidance from extension workers, and the high cost of some spice additives. To improve the use of locally available medicinal plants, herbs, and spices, several recommendations were made: incorporating phytogenic feed additives into packaged forms at regional and national levels, such as by the Ministry of Agriculture; providing farmers with training on proper usage and educating them through agricultural officers and development agents; raising awareness about the potential of phytogenic feed additives to replace antibiotics; and conducting further research to identify and test the effects of those additives on chicken performance.

DECLARATIONS

Corresponding author

Correspondence and requests for materials should be addressed to; E-mail: minichle18@gmail.com; ORCID: https://orcid.org/0000-0001-7800-0877

Ethical consideration

This study was survey-based, and ethical approval is not required, as it was conducted using a questionnaire. Before collecting survey data, each respondent was briefed on the purpose of the survey, the confidentiality of the information, and the expected duration of the interview. The interviews were conducted with a sample of smallholder chicken producers, and their willingness to participate served as their verbal consent.

Data availability

Data are available from the corresponding author (minichle18@gmail.com) upon reasonable request.

Authors' contribution

M. Yigrem designed the study, performed data collection, analyzed the data and drafted the manuscript, while Dr. G. Animut and Prof. Y. Mekuriaw meticulously designed the study, rigorously edited the manuscript, and provided final approval of the manuscript.

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Competing interests

The authors declare no competing interests in this research and publication.

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