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Nutritional and Ethno-Medicinal Potentials of Egg-Lime-Molasses Mixture in Livestock Production

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Abstract

Background: The quest for organic agriculture has necessitated the search for natural products which are abundant in phytochemicals and have significant therapeutic effects. This study was carried out to investigate the nutritional and ethno-medicinal potentials of egg-lime-molasses mixture (ELM).

Methods: Fresh eggs were placed in a bowl after which 1 liter of lime juice and 500 g of molasses were added into the same bowl, then it was covered tightly and left for 10 days at temperature of 27°C and relative humidity of 61%. At the end of 10 days, the egg shells were dissolved into solution and then blended together. The mixture was then analyzed for proximate composition, phytochemicals, minerals and vitamins. The analyses were investigated in accordance with standard procedures.

Result: Proximate analysis of ELM indicated the presence of moisture content (19.60%), crude protein (15.20%), lipids (5.50%), ash (14.60%), crude fibre (9.60%), carbohydrates (35.20%), fatty acid (4.40%) and energy (1060.30 Kcal/100 kg). Phytochemical screening revealed that ELM contained alkaloids, flavonoids, glycosides, saponin, steroids, phenols, terpenoides, tannin and antraquinones. Quantitative evaluation of the phytochemicals showed that ELM contained alkaloids (8.46 mg/100 g), flavonoids (2.30 mg/100 g), glycosides (0.08 mg/100 g), Saponin (5.25 mg/100 g), steroids (0.22 mg/l00 g), phenols (0.09 mg/100 g), terpenoides (0.56 mg/100 g), tannin (8.34 mg/100 g) and antraquinones (1.60 mg/100 g) and the vitamin constituents are Vitamin A (3.20 mg/100 g), Vitamin B1(280 mg/100 g), Vitamin B2 (880 mg/100 g), Vitamin B3 (340 mg/100 g), Vitamin C (15.40 mg/100 g) and Vitamin E (0.015 mg/100 g). Mineral analysis showed that it contained calcium (29.95%), magnesium (4.08%), potassium (23.20%), sodium (0.38%), phosphorus (6.90%), chlorine (0.30%), manganese (1.44 ppm), iron (3.60 ppm), aluminum (5.35%), titanium (2.10 ppm) and silicon (22.70 ppm). It was concluded that ELM is rich in various nutrients and phytochemicals conferring it the ability to perform multiple biological activities and as a natural alternative to antibiotics especially in monogastric animal production.

Key words: Antibiotics, Mineral, Phytochemicals, Proximate composition, Vitamins.

Introduction

Animal feed has frequently used antibiotic growth promoters, especially in the pig and poultry sectors (Paul *et al*., 2007). They are believed to improve gain and feed conversion by stabilizing the intestinal micro flora and preventing some specific intestinal infections (Waldroup *et al*., 2005).

Consumers and regulatory bodies are putting more pressure on the livestock industry to phase out or minimize the use of antibiotic growth promoters because of antibiotic resistance and the risk it poses to human health. Organic acids, such as formic, citric, ascorbic, acetic and butyric acids, among others, have been shown to be effective antibiotic alternatives by altering intestinal pH, enhancing digestion and increasing nutritional absorption (Adams, 1999).

The synthetic organic acids that are now in use are costly and unavailable to most farmers. It is crucial to examine the natural ecosystem in order to find and utilize some natural sources of organic acids, especially in light of the campaign in favor of organic farming or the use of natural feed additives in meat animal feeds (Adams, 1999; Akintunde and Toye, 2022). Lime juice can be used for this since it is a good source of organic acids including citric and ascorbic acids (Holden *et al*., 2005). There was a claim that lime juice included additional biomolecules, including flavonoids and carotenoids (Holden *et al*., 2005).

The sticky, black by-product of turning sugar cane or sugar beets into sugar is called molasses. For farm animals, molasses can be a great source of minerals and rapid energy (Senthilkumar *et al*., 2016). All ruminant livestock can benefit from molasses inclusion in their diets and it can be a very economical approach to boost feed palatability while also adding healthy amounts of protein and calories. Some finely

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milled feeds can become less powdery and dusty by adding molasses. This function involves making a feed mixture tastier and consumable for livestock. Molasses can be applied to low-quality forages, especially those with low sugar levels, to replenish lost sugar and trace minerals and to aid in fermentation. According to Senthilkumar *et al.* (2016), adding molasses to cattle's diets has the following positive effects: it increases milk solid production, improves diet density when intake is reduced prior to calving, improves milk let-down, improves digestion of fiber, lessens heat-related stress, promotes the growth and development of young stock and boosts pregnancy rates (condenses calving patterns). According to Senthilkumar *et al*. (2016), molasses has advantages for sheep and goats, including preventing toxemia during pregnancy.

Touchette *et al*. (2003) found that when provided at levels up to 10% of the diet in a conventional feeding schedule of 0.45 kg per head per day, egg is a useful substitute protein source for milk protein in calf milk replacers. The semen extender's egg yolk controls the efflux of integral protein, phospholipids and cholesterol, preventing temperature-related damage to the plasma membrane (Forouzanfar *et al*., 2010).

The aim of this study was to determine the composition of egg lime molasses mixture in terms of proximate, phytochemicals, minerals and vitamins in order to assess its potential for use in livestock feeds.

MATERIALS AND METHODS

The study was conducted at the Animal Laboratory of the Department of Agriculture and Industrial Technology, Babcock University, Ilishan-Remo, Ogun State, Nigeria situated in the South-Western rainforest belt with annual rainfall of 1500 mm and mean daily temperature of 28°C within Latitude 60 52′N and Longitude 30 43′E.

Sample preparation

It was ensured that the eggs were very fresh and this was ascertained by placing the eggs inside water. The fresh eggs were then placed in a bowl after which 1 liter of lime juice and 500g of molasses were added into the same bowl, then it was covered tightly and left for 10days at temperature of 27°C and relative humidity of 61%. At the end of 10 days, the egg shells had dissolved into solution. The entire solution was then blended together.

Proximate, phytochemical, minerals and vitamins of egg lime molasses Mixture

The parameters determined for proximate analysis include: Moisture, dry matter, crude fiber contents, total ash and fat content, protein and carbohydrate contents of the sample. These were determined according to the procedures of AOAC (2000). The methods of Akinyeye *et al.* (2010, 2011) were used to estimate the calorific (energy) value, the Atwater factors of 17, 17 and 37 are compounded by the value of starch, protein and crude fat, respectively (Akinyeye *et al*., 2011; Kilgour, 1987). Crude fat was converted to fatty acid by multiplying with a conversion factor of 0.80, as described by Akinyeye *et al.* (2010, 2011) and Greenfield and Southgate (2003).

Standard spectrophotometric and titrimetric methods were used in the determination of phytochemical contents of the mixture. Flavonoids were determined using the methods of Boham and Kocipai (1994). Saponins, phenols and glycosides were determined according to the procedures of Obadoni and Ochuko (2001) while alkaloids were determined according to the procedures of Harbone (1973). Oxalates and tannins were determined by titrimetric methods of Onwuka (2005).

The mineral contents (elements) of egg lime molasses mixture were determined using an atomic absorption spectrophotometer (AAS-Buck 205), as described by the Association of Official Analytical Chemists (AOAC, 1990) for calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), iron (Fe), zinc (Zn), manganese (Mn) and copper (Cu). Colorimetric method was used to determine phosphorus levels (AOAC, 1990). Both of the analyses were repeated a total of two times. Calcium, magnesium and potassium were measured in percentages, while sodium, iron, zinc, phosphorus, manganese and copper were measured in parts per million (ppm).

Standard spectrophotometric methods of AOAC (1990) and Okwu (2004) were used in the determination of all the vitamin contents of the mixture except vitamin C that was determined using titrimetric method (Okwu, 2004).

Statistical analysis

All data was analyzed using descriptive statistics in SPSS Version 22. As statistical values, the mean and standard deviation were calculated.

RESULTS AND DISCUSSION

Table 1 showed the proximate composition of ELM and it contained: moisture content (19.60%), crude protein (15.20%), lipids (5.50%), ash (14.60%), crude fibre (9.60%), carbohydrates (35.20%), fatty acid (4.40%) and energy (1060.30 Kcal/100 kg). Table 2 showed the phytochemical screening of ELM and it contained alkaloids, flavonoids, glycosides, saponin, steroids, phenols, terpenoides, tannin and antraquinones. Table 3 showed that egg lime molasses

Table 1: Proximate analysis of egg lime molasses mixture.

Parameter	Composition
Moisture content (%)	19.60±0.20
Crude protein (%)	15.20±0.40
Lipids (%)	5.50±0.10
Ash (%)	14.60±0.20
Crude fibre (%)	9.60±0.30
Carbohydrates (%)	35.20±0.20
Energy value (Kcal/100 kg)	1060.30±1.10
Fatty acid (%)	4.40±0.15

*Data are mean values±standard deviation (SD) of duplicate results.

mixture contained alkaloids (8.46 mg/100 g), flavonoids (2.30 mg/100 g), glycosides (0.08 mg/100 g), saponin (5.25 mg/100 g), steroids (0.22 mg/100 g), phenols (0.09 mg/100 g), terpenoides (0.56 mg/100 g), tannin (8.34 mg/100 g) and antraquinones (1.60 mg/100 g). Table 4 shows that egg lime molasses mixture contained Vitamin A (3.20 mg/100 g), Vitamin B1 (280 mg/100 g), Vitamin B2 (880 mg/100 g), Vitamin B3 (340 mg/100 g), Vitamin C (15.40 mg/100 g) and Vitamin E (0.015 mg/100 g). Table 5 shows that egg Lime Molasses mixture contained essential minerals: calcium (29.95%), magnesium (4.08%), potassium (23.20%), sodium (0.38%), phosphorus (6.90%), chlorine (0.30%), manganese (1.44 ppm), iron (3.60 ppm), aluminum (5.35%), titanium (2.10 ppm) and silicon (22.70 ppm).

It was observed that egg lime molasses mixture (ELM) had a moisture content of 19.60%. The high moisture content was because the sample was in aqueous solution. The high moisture content could also be due to the period of preparation of the solution which agrees with the observations of Nwadi *et al.* (2019) that the moisture content and pH of eggs increased with increase in storage time.

Protein content of ELM in this study was 15.20%. The protein content was however higher than the values obtained for most phytobiotics. The value obtained in this study was higher than 6.50% reported for molasses by Senthilkumar *et al.* (2016), 14.35% reported for *Ocinum gratissimum* by Olumide *et al.* (2019), 7.66% for *Citrus sinensis* fruits (Ndubuisi-Ogbonna *et al.*, 2021), 8.90 for unripe *Carica papaya* seeds (Akintunde *et al.*, 2021a), 5.87% and 7.09% for *Syzygium aromaticum* and *Curcuma longa,* respectively (Adebisi *et al.*, 2021). The higher protein values could be due to the addition of chicken eggs which has high values of protein.

The fat content of 5.50% in the study indicates that ELM has a moderate fat content. The value was higher than 2.90% observed for *Chromolaena odorata* leaf meal (Akintunde *et al.*, 2021b), 2.90% and 1.50% for *Syzygium aromaticum* and *Curcuma longa* respectively (Adebisi *et al.*, 2021), 4.20% for *Ocinum gratissimum* (Olumide *et al.*, 2019) but lower than 8.50% for *Citrus sinensis* fruits (Ndubuisi-Ogbonna *et al.*, 2021), 29.50% for unripe seeds of *Carica papaya* (Akintunde *et al.*, 2021a), 27.50% for ripe *Carica papaya* seed (Kolu *et al.*, 2021), 8.85% for fresh *Carica papaya* leaf (Olumide *et al.*, 2022) and 7.55% for *Phyllanthus niruri* leaf (Olufayo *et al.*, 2021).

The ash of food samples can be used to determine the organic content from which the mineral content can be derived (Bello *et al.*, 2008). The content of the solution (ELM) in the study was 14.60%. The value was higher than 3.67% for *Moringa oleifera* seed (Akintunde and Toye, 2014) and 11.50% for dried watermelon rind (Otu *et al.*, 2021). Also, the total ash content of 14.60% is higher than for most legumes; 2.00% in peas and 5.00% in soybean. This indicates that egg lime molasses solution is a good source of minerals required by livestock.

Crude fibre content of ELM in the study was 9.60%. The value of ELM is higher compared to the leaves of

Table 2: Phytochemical screening of egg lime molasses mixture.

Phytohemicals	Observation
Alkaloids	+++
Flavonoids	+
Glycosides	+
Saponin	++
Steroids	+
Phenols	+
Terpenoides	+
Tannin	+++
Antraquinones	+

+++ Present in high amount, ++ Present in moderate amount, + Present.

Table 3: Phytochemical analysis of egg lime molasses mixture

Parameter	Conc. (mg/100 g)
Alkaloids	8.46±0.05
Flavonoids	2.30±0.02
Glycosides	0.08±0.01
Saponin	5.25±0.02
Steroids	0.22±0.00
Phenols	0.90±0.01
Terpenoides	0.56±0.02
Tannin	8.34±0.05
Antraquinones	1.60±0.02

*Data are mean values±standard deviation (SD) of duplicate results.

Table 4: Concentration of vitamins in egg lime molasses mixture.

Vitamins	Conc. (mg/l00 g)
Vitamin A	3.200±0.02
Vitamin B1	280.200±0.15
Vitamin B2	880.300±0.05
Vitamin B3	340.200±0.10
Vitamin C	15.400±2.00
Vitamin E	0.015±0.01

*Data are mean values±standard deviation (SD) of duplicate results.

Table 5: Mineral composition of egg lime molasses mixture.

Parameter	Composition
Calcium (%)	29.95
Phosphorus (%)	6.90
Potassium (%)	23.20
Sodium (%)	0.38
Chlorine (%)	0.30
Magnesium (%)	4.08
Manganese (ppm)	1.44
Silicon (ppm)	22.70
Aluminum (%)	5.35
Iron (ppm)	3.60
Titanium (ppm)	2.10

Legend: Calcium-Ca, Magnesium-Mg, Potassium-K, Sodium-Na, Phosphorus-P, Manganese-Mn, Iron-Fe, Aluminum-Al, Titanium-Ti and Silicon-Si.

Ocinum gratissimum (7.60%), *Vernonia amygdalina* (8.90%) and *Moringa oleifera* (8.00%) reported by Olumide *et al.* (2019) but lower than 10.78% reported for *Chromolaena odorata* leaf (Akintunde *et al*., 2021b) and 13.02% reported for *Citrus sinensis* fruits (Ndubuisi-Ogbonna *et al*., 2021). High dietary soluble fibre is advantageous because it reduces the risk of serum cholesterol level, coronary disease and promotes digestion in animals (Soliman, 2019). This however suggests that ELM would provide high dietary fibre in a diet. This indicates that the fiber (roughage) content of this mixture is high and will promote digestion and prevent constipation when consumed.

The carbohydrate content of ELM in the study was 35%. The value obtained for carbohydrate was lower when compared to 37.95% reported for lime (*Citrus aurantifolia*) by Williams *et al.* (2020) and the ranges from 70 to 81% observed in the peels of *C. grandis*, *C. reticulata*, *C. paradisii* and *C. sinensis* by Ezeabara and Okeke (2019) but higher than 16.79% reported for *Citrus maxima* juice by Ani and Abel (2018) and 29.47% reported for *Carica papaya* seed by Kolu *et al.* (2021). The value reported was also lower than the values of 12.7-36.5 g/kg and 35.0-96.2 g/kg observed for egg yolk and egg albumen respectively by Antova *et al.* (2019) but higher than 0.3 g/50 g reported for whole chicken eggs by Pal and Molnar (2021).Thus, the carbohydrates contents of ELM are relatively high and carbohydrates are known to produce energy required for the body because they are essential nutrients for adequate diet and supplies energy to cells such as brain, muscle and blood (Ejelonu *et al*., 2011).

The value estimated for energy in the present study was 1060.30 Kcal/100 kg. This value was lower than the ranges of 29.06-30.51 MJ/kg and 19.77-20.93 MJ/kg reported for chicken egg yolk and albumen respectively by Antova *et al.* (2019) and 85 Kcal/50 g reported for whole egg by Pal and Molnar (2021). Also, the value of fatty acid estimated in this study (4.40%) was higher than 1.69% reported by Ogbe and Affiku (2011) for *Moringa oleifera* leaves. The presence of these important nutrients like carbohydrate, low crude fat and fatty acid means egg lime molasses mixture could be used as a nutritionally valuable and healthy ingredient to improve poultry health and growth performance. Low fat foods are known to reduce cholesterol level (Gordon and Kessel, 2002).

Phytochemical components indicated that ELM contained alkaloid, saponin, flavonoids, glycosides, steroids, phenols, terpenoides, antraquinones and tannin. The levels of these anti-nutrients were low. Because studies have connected these compounds to a variety of bioactivities, the presence of phytochemicals (such as saponins, flavonoids, coumarins and phenols) in plants may imply that they have antibacterial potentials against human diseases (Ajaiyeoba *et al*., 2003; Nwokonkwo, 2009; 2013; Nwokonkwo, 2014).

Alkaloids are naturally occurring, poisonous amines that plants manufacture primarily as a defense against herbivores. Alkaloids' primary harmful effects include disruptions of the immune system, reproductive system, digestive system and central nervous system. The presence of bioactive compounds in 100 g of citrus comprised alkaloids (0.4 mg) as reported by Narang and Jiraungkoorskul (2016) which was lower than 8.46 mg/100 g observed in the present study.

While some flavonoids have potential antiviral properties, many flavonoids have been proven to have antioxidative activity, free radical scavenging capability, coronary heart disease prevention, hepatoprotective, anti-inflammatory and anticancer actions. Flavonoids function as growth regulators and antioxidants in plant systems (Kumar and Pandey, 2013). The value obtained in this study (2.30 mg/100 g) was higher than 0.6 mg/100 g reported for five varieties of citrus species; *C. sinensis*, *C. reticulata*, *C. limonum*, *C. aurantifolia* and *C. grandis* (Narang and Jiraungkoorskul, 2016).

Organic compounds known as glycosides can be extracted from both plant and animal sources. When the glycosidic bond of glycosides is hydrolyzed by an enzyme or an acid, one or more sugar moieties and non-sugar entities are released (Bartnik and Facey, 2017; Deshpande *et al*., 2017). The anti-inflammatory, analgesic and antioxidant properties of glycosides were described by Backhouse *et al.* (2008). The outcome was in line with Suntar *et al*. (2018)'s findings, which proved the existence of glycosides in *Citrus aurantium*.

Saponins have powerful anti-inflammatory effects that can effectively treat mouse edoema (Fahrunida and Pratiwi, 2009). High amounts of saponins in feed have an impact on chicken development rate and feed intake (Sim *et al*., 1984; Potter *et al*., 1993; Dei *et al*., 2007). Additionally, saponins have hemolytic properties against RBC (Khalil and Eladawy, 1994). The amount of saponin found in the current study, 5.25 mg/100 g, was less than the 14 per cent found in Solanum aethiopicum (Eze and Kanu, 2014). Saponin may be helpful in regulating blood lipids, reducing the risk of cancer, improving blood glucose control and having antioxidant properties (Igidi and Edene, 2014). Hence, ELM could be a potential antioxidant and energy source for livestock especially monogasstric animals.

In addition to reducing inflammation, steroids also help the skin's immune system function (Iniaghe *et al*., 2009). Steroids were also found, albeit at a lower level (0.22 mg/100 g) than the 0.42 mg/100 g observed for *C. auranifolia* seed (Williams *et al*., 2020). As arrow poisons or heart medications, steroids are phytoconstituents that have been shown to have therapeutic uses (Timothy, 2018). A tiny quantity of the steroid component in the ELM may help animals with wasting disease and osteoporosis retain nitrogen (Maurya *et al*., 2008; Madziga and Sandabe, 2010).

It has been shown that saponins, flavonoids, coumarins and phenols have antibacterial potentials against pathogenic organisms (Seghosime *et al*., 2017). Additionally, phenols were found (0.90 mg/100 g), albeit in lower amounts than the 19.87 mg/100 g seen in the seeds of *C. aurantifolia* (Williams *et al*., 2020). Most polyphenols are germicidal, commonly employed in disinfectant formulations and others have estrogenic or endocrine disrupting action (Williams *et al*., 2020). Hence, it can be said that ELM has anti-oxidative, anti-inflammatory, anti-allergic, anti-thrombotic and antibacterial effect.

Terpenoids was present (0.56 mg/100 g) which was lower than 0.87 mg/100 g observed for *C. aurantifolia* seed by Williams *et al.* (2020). Terpenoids possess medicinal properties such as anti-carcinogenic, antimalarial, antiulcer, antimicrobial or diuretic activity (Dudareva *et al*., 2004). Terpenoids were found, however the level was lower than Williams *et al*. (2020)'s observation of 0.87 mg/100 g for *C. aurantifolia* seed.

Plant polyphenols including tannins have the capacity to form compounds with metal ions as well as large molecules like proteins and polysaccharides (De-Bruyne *et al*., 1999; Dei *et al*., 2007). Dietary tannins may decrease the effectiveness of feed and weight increase in chicks (Armstrong *et al*., 1974; Dei *et al*., 2007). The amount of tannin detected (8.34 mg/100 g) in this investigation was lower than the 6.13 mg/100 g for *Citrus aurantifolia* (lime) seed reported by Williams *et al.* (2020). Because tannins are known to have anti-microbial properties, they are crucial for the healing of wounds (Zida *et al*., 2016). However, caution should be taken in the administration of ELM to monogastric animals.

It has been demonstrated that anthraquinones are powerful inhibitors of the production of aflatoxin B (1)-8, 9-epoxide (Lee *et al*., 2001). Anthraquinone is a promising antimalarial and antibacterial agent, according to Eyong *et al*. (2006). Anthraquinone (AQ) can lower methane production in both *in vitro* and *in vivo* ruminal fermentations, according to Hession *et al*. (1995). Hession *et al*. (1995) similarly came to the conclusion that a 19-day feeding trial with lambs showed no rumen adaptation to the depression in methane and that high levels of AQ have no influence on liver function enzymes or other blood measures. This justifies the antimicrobial potential of ELM in livestock production.

The observations from this study showed that ELM contained Vitamin A (3.20 mg/100 g), Vitamin B1 (280.20 mg/100 g), Vitamin B2 (880.30 mg/100 g), Vitamin B3 (340.20/100 g), Vitamin C (15.40 mg/100 g) and Vitamin E (0.015 mg/100 g). Vitamins are very important for the growth and development of birds and they're provided to meet up with their nutritional need. Deficiencies in any of these components many lead to a negative effect which will result into economic lose to farmer (Ewing and Charlton, 2007). Vitamins are necessary organic molecules that are involved in key bodily processes like growth, health maintenance and metabolism (Gropper *et al*., 2005). Vitamins C and E are antioxidants; they neutralize the effects of free radicals and prevent diseases. ELM contained 15.4 mg/100 g and 0.015 mg/100 g of vitamins C and E which were lower than the values reported for *Citrus maxima* juice and peel (Vitamin C-26.36 mg/100 g and 19.34 mg/100 g for *Citrus maxima* juice and peel respectively and Vitamin E-2.11 mg/100 g and 4.45 mg/100 g for *Citrus maxima* juice and peel respectively) as reported by Ani and Abel (2018). ELM had relatively higher level (280.2 mg/100 g) of vitamin B1 (thiamin) which was much higher than 11.20 mg/100 g observed for *Citrus maxima* peels by Ani and Abel (2018). Thiamin deficiency in the diet can lead to a general slowing down of the metabolism of carbohydrates and its connection to the metabolism of amino acids (*via* "keto acids") has serious repercussions, including a reduction in the production of acetylcholine, which is essential for neural function (FAO/WHO, 2001). ELM is also an excellent source of vitamins B2 (*riboflavin*) and B3 (*niacin*) as the values (0.75 and 3.88 mg/100 g) obtained were much higher than the values reported for ripe *Carica papaya* (Kolu *et al*., 2021) and 0.069% and 1.063% for clove (Adebisi *et al.*, 2021). However, this raises the possibility that ELM could take the place of commercial vitamin premix, particularly in the case of monogastric animals.

In this investigation, ELM had a sizable amount of minerals. The findings of this investigation indicated that the mineral analysis of ELM contained some significant essential minerals such as; calcium (29.95%), phosphorus (6.90%), potassium (23.20%), sodium (0.38%), chlorine (0.30%), magnesium (4.08%), manganese (1.44 ppm), silicon (22.70 ppm) and aluminum (5.35 ppm). The presence of such minerals in ELM could be utilized as nutritionally valuable additives or supplements in monogastric animals' production. Macronutrients including minerals are crucial in human and livestock nutrition and they promote health (Nwozo *et al*., 2021). An essential macronutrient for many bodily physiological and biochemical processes is calcium (Nwozo and Nwawuba, 2018). The calcium content in ELM was 29.95% which was much higher than 16.20 g/kg reported for *Citrus sinensis* fruits (Ndubuisi-Ogbonna *et al.*, 2021). The value of calcium in ELM is more than the daily calcium requirement for laying birds (3.25 per cent) and adequately meets the daily requirements of all other classes of birds (NRC, 1994; Atteh, 2015). The high calcium content could be as a result of the shells of chicken eggs present in ELM.

ELM was found to be a rich source of phosphorus with a concentration of 6.90% which was much higher than 0.95 g/kg reported for fruits of *Citrus sinensis* (Ndubuisi-Ogbonna *et al*., 2021) and 108.16 mg/100 g reported for *C. aurantifolia* seed (Williams *et al*., 2020a). Phosphorus contents of ELM solution was however higher than the recommended 0.4-0.5% for poultry (NRC, 1994; Atteh, 2015). ELM was discovered to be a rich source of phosphorus and phosphorus functions in the maintenance of blood sugar levels and normal heart contraction (Williams *et al*., 2020b). Phosphorus is also crucial for healthy bone development, renal function and appropriate cell growth and repair. It is highly essential for preserving the body's acid-alkaline equilibrium (Ramadass and Subramanin, 2018). Calcium and phosphorus are associated with each other for growth and maintenance of bones, teeth and muscles (Ladan *et al.*, 1996; Okaka *et al.*, 2006).

Potassium plays highly significant role in maintaining fluid balance and transmitting nerve impulses (Ani and Abel, 2018). 23.20% observed for potassium in this study was much higher than 1.30 mg/100 g reported for *Citrus maxima* juice (Ani and Abel, 2018). Thus, ELM is an excellent source of potassium with much potential in animal nutrition.

The sodium content in ELM was 0.38% and this was higher than 1.27 g/kg for *Citrus sinensis* (Ndubuisi-Ogbonna *et al.*, 2021) and 0.08% reported for ripe seeds of *Carica papaya* (Kolu *et al.*, 2021) and 4.60 mg/L reported by Nwozo *et al.* (2021) for *Citrus sinensis* seed oil. The principal positive ion (cation) in extracellular fluid is sodium, which is essential for sustaining bodily fluid. Phosphorus has active functions in a number of biologically significant substances, including involvement in the production of nucleic acids, energy transfer and storage, cell membrane structure and acid-base balance as well as the mineralization of bones (Gropper *et al.*, 2005).

The photosynthetic molecule's porphyrin contains magnesium at its core. As the centre of the heme group in haemoglobin and the source of the red hue of the blood, iron is an essential metal for the human body (Nwozo *et al.*, 2021). Convulsions are caused by magnesium deficiency, while calcium is crucial for preserving the body's tissues and bones (Kouris-Blazos and Belski, 2016). The mean magnesium content of ELM was 4.08% which was much higher than 1.25 g/kg for *Citrus sinensis* fruits (Ndubuisi-Ogbonna *et al.*, 2021). The magnesium content observed in this study was however higher than 0.15% and 0.13% reported by Kolu *et al.* (2021) and Akintunde *et al.* (2021) for ripe and unripe seeds of *Carica papaya* and 6.22 mg/L reported by Nwozo *et al.* (2021) for *Citrus sinensis* seed oil. ELM is however a good source of magnesium.

Manganese supports both energy production and the immunological system (Muhammad *et al.*, 2011). However, the value observed for manganese was significantly lower than the values of 31.21-32.62 mg/kg and 26.91 mg/kg reported for ripe and unripe seeds of *Carica papaya* by Kolu *et al.* (2021) and Akintunde *et al.* (2021a) respectively.

CONCLUSION

This study has demonstrated that egg lime molasses mixture (ELM) is rich in constituents, including the substances that have been reported to cause coagulation (tannins and natural polymers like proteins), as well as other substances (such as saponins, flavonoids, coumarins and phenols) that have antibacterial potentials against pathogenic organisms.

According to the study, ELM contains phytochemicals, elements, proximate nutrients and anti-nutrients, all of which are necessary for human and animal nutrition. These nutrients can be added to feed to help humans and animals grow more quickly and healthily and they can also be used in the pharmaceutical industry to make drugs. According to the study, ELM is a rich source of protein, fat, carbohydrates and several minerals like calcium, phosphorus, potassium and magnesium.

A good source of crucial minerals and phytochemicals is ELM. It is crucial to include ELM in food products intended for human and livestock consumption in order to boost the product's flavour and acceptability as well as its phytochemical and nutritional densities. ELM may support physiological processes in poultry and livestock and lower the risk of chronic diseases. This study has demonstrated the high nutritional value and ethno-medicinalpotential of ELM.

Conflict of interest: None.

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