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Evaluation of the Nutritive and Phytochemical Properties of *Citrus sinensis* Fruits as a Feed Ingredient in Livestock Production

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ABSTRACT

The study was conducted to evaluate the nutritive and phytochemical properties of *Citrus sinensis* fruits as a feed ingredient. This is necessary to guard against wastage of these fruit on a yearly basis. Atomic absorption spectrometry was used in determination of the fruits for minerals (sodium, calcium, phosphorus, potassium, magnesium, iron), proximate analysis was done using the procedures of Association of Analytical Chemists and phytochemicals (total phenolics, tannin, alkaloid, saponin) were also determined using appropriate techniques by the Association of Analytical Chemists. The result showed that the fruits of *Citrus sinensis* contained moisture content, ash, crude protein, crude fibre, ether extract, nitrogen free extract values of 6.40%, 7.25%, 7.66%, 13.02%, 8.50% and 63.56% respectively. The fruits of *Citrus sinensis* contained minerals (g/kg) such as Na (1.27), Ca (16.20), P (0.95), K (8.90), Mg (1.25) and Fe (76). Phytochemical evaluation revealed that the fruits of *Citrus sinensis* have phenols (0.05 mg/100g), saponin (0.15g/100g), alkaloid (0.63 mg/100g) and tannin (0.04 mg/100g). The results indicated that the fruits of *Citrus sinensis* may serve as a feed ingredient diet based on the nutritive evaluation of the ingredients. Also with the resultant phyto-chemicals attributes it could serve as feed additives in monogastric animal production

Keywords: Animal, Mineral, Phytochemical, Production, Proximate

INTRODUCTION

Oranges and grape fruits, as well as lemons sometimes go to waste if they are not marketed. Citrus fruits are notable for their fragrance partly due to flavonoids and limonoids contained in the rind. The juice contains a high quality of citric acid giving them their characteristic sharp flavour. They are also good source of Vitamin C and flavonoids [1, 2].

Pigs prefer oranges and tangerines to grapefruit and the free choice feeding of citrus fruits, together with a protein supplement, has given good results with these animals [3]. Feed accounts for 55-75% of the cost of input in monogastric animal production and this have necessitated the use of alternative feed ingredient [4].

On an estimated 3 million hectares of land in Nigeria, about 930,000 tons of citrus fruits are produced each year [5]. However, between 30 and 50 per cent of these citrus fruits perish on their journey to the end customers in urban areas. As a result, it is considered a waste and has an environmental impact [5].

This study aimed at determining the proximate, mineral and phytochemical composition of *Citrus sinensis* fruits as a potential alternative feeding stuff to livestocks. This is necessary as a lot of fruits of *Citrus sinensis* waste every year either as unsold fruits or drop directly from the trees. This study however was focused on the nutritive and phytochemical potentials of this fruit in livestock production. Citrus fruits can easily be collected free from a citrus orchard or at a very low cost and this will significantly reduce the cost of feeding the animals. Also, for a livestock farmer that also has a citrus orchard, it is an advantage as the citrus droppings or waste citrus fruits that cannot be purchased by prospective buyers can now be used to feed the swine. This citrus will be collected free and the cost of processing will be minimal compared to purchasing a whole lot of conventional feed ingredients. Also, the availability of citrus makes its use as feed ingredient worthwhile since citrus is found and always become surplus at a particular season of the year. During this time a lot of the fruits normally rot and waste away.

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.

Collection of Samples

Fruits of *Citrus sinensis* were collected at Nigerian Horticultural Research Institute (NIHORT), Ibadan, Nigeria.

Analysis of Samples

The proximate composition of the sample was determined. The fresh citrus fruits were sliced to reduce the surface area and to facilitate drying. The cut samples were oven dried for 96 hours at 105 ºC. The dried Citrus droppings' sample was milled and representative samples were taken for proximate analysis.

Samples were analyzed for Crude Protein, Dry Matter, Ash, Crude Fiber, Ether Extract and Nitrogen Free Extract using the procedure described by AOAC [6].

Minerals content was analyzed using spectrophotometric methods according to the standard procedure as described by AOAC [7]. Sample was analyzed for sodium, potassium, calcium, iron, magnesium and phosphorus

The methods of Sofowora [8] were used to assess quantitative phytochemical analyses of anti-nutrients. All of the tests were done in duplicates. The samples were analysed for saponin, alkaloid, phenol and tannins.

RESULTS AND DISCUSSION

Table 1 showed the nutritive evaluation of the *Citrus sinensis* fruits. It indicates that it has 7.66% crude protein, 7.25% ash, 13.025% crude fibre, 8.5% ether extract and 63.565% Nitrogen Free Extract (NFE).

The mineral analysis of *Citrus sinensis* fruits is presented in Table 2. The mineral composition analysis of *Citrus sinensis* droppings indicates the presence of calcium (16.20 g/kg), potassium (8.90 g/kg), magnesium (1.25 g/kg), sodium (1.27 g/kg), phosphorous (0.95 g/kg), and iron (76.00 g/kg).

Phytochemical compositions of *Citrus sinensis* droppings are presented in Table 4. Alkaloid was found to be the abundant constituent making about 0.63 mg/100g, followed by saponin, phenol and tannin with values of 0.15 mg/100g, 0.05 mg/100g and 0.04 mg/100g respectively.

Table 1: Proximate Composition of *Citrus sinensis* Fruit

NUTRIENT	COMPOSITION
Dry matter	6.40%
Ash	7.25%
Crude Protein	7.66%
Crude Fibre	13.02%
Ether Extract	8.50%
Nitrogen Free Extract	63.56%

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

Table 2: Mineral Composition of *Citrus sinensis* Fruit

PARAMETER	COMPOSITION
Calcium (g/kg)	16.20±1.13
Phosphorus (g/kg)	0.95±0.07
Magnesium (g/kg)	1.25±0.07
Potassium (g/kg)	8.90±0.71
Sodium (g/kg)	1.27±0.09
Iron (g/kg)	76.00±5.66

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

Table 3: Phytochemicals of *Citrus sinensis* Fruit

PARAMETER	COMPOSITION
Saponin (mg/100g)	0.15±0.09
Alkaloid (mg/100g)	0.63±0.01
Phenol (mg/100g)	0.05±0.05
Tannin (mg/100g)	0.04±0.01

Legend: *Data are mean values ± standard deviation (SD) of duplicate results, HCN- Hydrogen Cyanide

The crude protein value of the *Citrus sinensis* fruits (7.66%) is close to the crude protein value of maize (8.75%) and sorghum (9.10%) [9] and 8.63% for oven-dried ripe seeds of *Carica papaya* [10]. In addition to maize, sorghum among other cereals has been investigated as a dietary energy source in poultry, swine and rabbit diets [11]. The ash content of the *Citrus sinensis* fruits which is approximately 7.25% is higher than 2.19% for maize [9], 1.90% [12] and 2.07% [9] for sorghum, 4.57% for cassava root meal [13] and 3.67% for *Moringa oleifera* seed meal [14]. This shows that compared with maize and sorghum, the droppings of *Citrus sinensis* has the potential of being a rich minerals source.

The droppings of *Citrus sinensis* have a crude fibre of 13.025%. This is appreciably higher compared with 2.04% for maize [9] and 0.619 for *Citrus sinensis* seed oil [2] but close to 13.6-14.9% crude fibre of citrus fruit peel meals [15]. The dietary implication of a high crude fibre diet may limit its maize replacement value in the diets of monogastric animals, most especially poultry and swine because of the low dietary fibre utilization efficiency of these livestock species but good potential nutrient source for ruminants.

The Nitrogen Free Extract from the *Citrus sinensis* fruits which is the portion of carbohydrates is 63.565%. The value is lower than that of 82.85% for maize and 70.11% for maize processing waste but close to that of citrus fruit peel meal which is 65.50% [15, 16] and 87.64% for cassava root meal [13]. Hence using the fruits of *Citrus sinensis* in diet formulation may require calorie boosting to improve the nutritional value of the diet.

The ether extracts obtained from the fruits of *Citrus sinensis* is 8.50% and is higher than 2.40% reported for maize [9] 3.00% for yellow sorghum [12] and 2.35% for citrus fruit peel meal [15].

Highlighting the nutritional benefit of sweet orange fruits is highly important because tonnes of these waste annually in orchards and farms.

The anti-nutrient composition of the *Citrus sinensis* fruits (Table 3) revealed that, phenol content was found to be 0.05±0.09 mg/100g, tannin 0.04±0.01 mg/100g, saponin 0.15±0.09 mg/100g and alkaloids 0.63±0.01 mg/100g. Correspondingly, the levels of these anti-nutrients were found to be within the safe limits. The levels of tannins above 5% in the diet are often lethal [17] and the tannin content found in this study was equivalent of 0.40%. Saponin at levels less than 10% is considered safe [18] and the level of saponin as observed in this study is 1.5% thus making the consumption by livestock safe.

The presence of phenolic compounds, tannins, saponins, enzyme inhibitors, and cyanogenic glycosides has been shown to reduce the availability of certain nutrients and impair growth [19]. The level of anti-nutrients (tannin, phenol, saponin, and alkaloid) present in the *Citrus sinensis* ranged within tolerable limit and cannot possibly prompt a toxic effect when consumed by livestocks.

Additionally, minerals are the macronutrients that are important for human nutrition and contribute to good health [2]. The result of this study (Table 2) revealed that, sweet orange (*Citrus sinensis*) fruits was found to contain Ca, Mg, K, Na, P and Fe (Table 3). The fruits of *Citrus sinensis* were found to be a rich source of phosphorus with a concentration of 0.95±0.07 g/kg. This was found to be lower than recommended 0.4-0.5% for poultry [4, 20] hence the diet can be fortified with dicalcium phosphate if it is to be offered to monogastric animals.

Calcium is an important macronutrient needed for various physiological and biochemical processes in the body [21]. The Ca content of the *Citrus sinensis* fruits was found to be 16.20±1.13 g/kg which is significantly lower than the daily calcium requirement for laying birds (3.25%) [4, 20] but sufficiently meet the daily requirements of all other classes of birds hence calcium can be supplemented from bone meal, oyster shell or dicalcium phosphate for laying birds.

Magnesium is located in the center of the porphyrin in the photosynthetic molecule. Iron is a vital metal in the human body, as it is the center of the heme group in haemoglobin and is responsible for the blood's red color [2]. The Fe content of the fruits of *Citrus sinensis* was found 79.00±5.66 g/k=Kg. The deficiency of iron leads to anemia. The presence of magnesium is associated with the release of parathyroid hormones in vital organs and tissues, oxidative phosphorylation, normal muscle contraction and relaxation and the conversion of vitamin D to its active form. The mean Mg content of *Citrus sinensis* fruits was 1.25±0.07 g/kg. Deficiency of Mg results in convulsion and calcium plays an important role in strengthening the tissues as well as bones of the body [22]. The magnesium content observed in this study was however lower than 0.15% reported by Kolu *et al* [10] for ripe seeds of *Carica papaya* but higher than 6.22 mg/L reported by Nwozo *et al* [2] for *Citrus sinensis* seed oil. The Na content in *Citrus sinensis* fruits was 1.27±0.09 g/kg). The sodium content observed in this study was however higher than 0.08% reported by Kolu *et al* [10] for ripe seeds of *Carica papaya* and 4.60 mg/L reported by Nwozo *et al* [2] for *Citrus sinensis* seed oil.

CONCLUSION

The fruit of *Citrus sinensis* which is often considered as wastes is a rich source of carbohydrates, crude fibre, ash, minerals, vitamins and phytochemicals. The results however indicated that the fruits of *Citrus sinensis* may serve as an alternative feed ingredient diet based on the nutritive evaluation of the ingredients. The presence of the phytochemicals may enhance the ethno-medicinal use of these ingredients.

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