Assessment of The Mineral Contents Phytochemicals nd Proximate Analysis of Seeds and Peels Of *Citrus limon* (Lemon)

K. O. Ijege*, I. Umar and R. Suleiman

Department of Applied Chemistry, Kaduna Polytechnic, Kaduna-Nigeria
*(Corresponding author) io.king@kadunapolytechnic.edu.ng ; 08067217059

ABSTRACT

The study was carried out to assess the mineral content, phytochemicals and proximate analysis of the peels and seed of citrus limon. Analysis of the mineral was carried using Atomic Absorption Spectrophotometer and flame photometer. Phytochemicals and proximate analysis determination were done using standard methods. The citrus limon peels and seeds contain reasonable amount of important minerals such as Ca, K Mg, Na, Zn. Fe, Mn and Cu. Poisonous elements like Pb and Cd are present in very small quantity and these may be considered as food supplement especially for animals. The phytochemical analysis showed the presence flavonoids, tannins, alkaloids, saponins, phenols and steroids in both the citrus limon peels and seeds while terpenoid is present in only the peels. Substantial amount of nutritional components such as carbohydrate, fibre, lipids and proteins are also present. The peels and seeds of lemon may be used materials for drug production and nutritional supplements.

Keywords: Lemon, Phytochemicals, Mineral Contents, Proximate Analysis, FTIR

INTRODUCTION

Citrus Lemon is a hybrid of the genus citrus belonging to the family *Rutaceae*, a tree that is evergreen. Citrus species are trees or medium-size shrubs grown in tropics and subtropics. Other species of citrus include tangerine, grapefruits, sweet orange and sour orange. These fruits are extensively cultivated worldwide due to consumer high demand. About 31.2 million tons per year of citrus are processed globally[1]. Citrus is a very important crop grown in Nigeria. Between 2000 and 2004, 3% of the total world output for citrus was produced in Nigeria. The country was ranked ninth among major countries producing the different varieties of the fruits and is considered a major producer[2]. Citrus fruits are grown in farmlands in guinea savannah and rain forest of remote areas in the country. States in Nigeria that produce citrus include Benue, Kaduna, Imo, Delta, Taraba, Kwara, Osun, Oyo, Nassarawa, Ogun, Ekiti, Kogi, Edo and Ebonyi.

Lemon is known for its distinct quality and value in virtually all facet of life link with medicine, food or nutrition[3]. All parts of lemon are useful and have high potency in the treatment of some ailment. Its juice is used in reducing fever and blood pressure. Oils extracted from the leaves which are regarded as waste can be used as a preserving agent and can also be used for other nutritional and medicinal uses[4]. Lemon is helpful for treating sore throat when honey is added to it and aid in weight loss when mixed with water. Several disorders can be treated at home using lemon owed to less cost, availability and unique properties; it is used to treat aches and diseases[5]. The peels of lemon can be utilized and used as a great source of feeds for animals and nutraceuticals[6]. They can also be used to provide antioxidant substances dietary fibres and minerals in dietary supplements and foods. Large animals like cattle are fed with dried pulp mixed with dried rind of citrus lemon[7]. The study was carried out to assess the metal content, phytochemicals, proximate analysis and characterization of the seeds and peels of *citrus limon* (lemon).

MATERIALS AND METHODS

Plant material collection

Lemon peels and seeds used in this work were purchased on 16th of November, 2022, from Bakin Dogo Market; Kaduna State. The freshly collected lemon were properly washed to remove dirt, peeled with knife and dried for three weeks. The dried lemon peels and seeds were then ground separately using mortar and pestle. The powdered materials were then properly packed into neat plastic bottles in preparation for further analysis.

Preparation of standard

Standard solutions were prepared for all the elements studied in five various concentrations by diluting from standard stock solution of 1000 ppm to get a calibration curve.

Sample Analysis

The lemon samples were digested using wet digestion. 1 gram of the samples was separately weighed into a 100 ml volumetric flask. 10 ml of HNO_3 was added and the mixture kept for a few hours before it carefully transferred over a water bath and heated until the red fumes from the flask has disappeared. The flask was removed and

allowed to cool to room temperature. 10 ml of perchloric acid was added to the flask and transferred again to the water bath to reduce to a small amount. The mixture was allowed to cool and then filtered through a Whatman no. 42 filter paper. This was then diluted with the de-ionized water to 100 ml. An AA6800 Atomic Absorption Spectrophotometer and flame photometer were used to determine the various elements. Samples and standard prepared were done in triplicate.

Preparation of extract

Maceration method was used for the extraction. 200 g of the lemon seed and peels were weighed separately using an electronic weighing balance and transferred into a flat bottom flask. 500 ml of methanol was measured and transferred into the flask having the sample. This mixture was shaken with a shaker for 3 hours and left for 4 days with frequent shaking. The sample was filtered five times using a funnel and filter paper. The filtrate was placed in an open space for the methanol to evaporate leaving the seeds and peels extract.

Phytochemical Screening of Citrus Limon

Phytochemical components of the methanol extract of seeds and peels of *Citrus limon* was screened using standard outlined procedures by[8,9]. The components analyzed are Alkaloids, Flavonoids, Saponins, Phenol, Tannins, Steroids, Anthraquinone, Terpenoids, Phlobatannins and Cardiac glycosides.

FTIR Analysis

The FTIR analysis was done on the methanol extract of the peels and seeds of the *citrus limon* by diluting them separately with few drops of methanol. One drop of the diluted extract was then mixed with 50 mg KBr (FTIR-grade) was diluted with one drop of the peels and seed extract; the mixture was placed into the sample cup and inserted in the photo acoustic cell which is sealed for measurement. The scanning absorption range was 630 to 4000 cm^{-1}.

Proximate Analysis

Pulverized dried peels and seeds of *citrus limon* were used for proximate analysis. This was done using standard methods[10]. The analysis was carried out in triplicate.

RESULTS AND DISCUSSIONS

Mineral composition

The mineral composition result is given in table 1. This shows that the *citrus limon* peels had a markedly higher sodium, calcium, magnesium, potassium and zinc (33.54 ± 0.01, 455.21 ± 3.16, 18.89 ± 0.01, 613.11 ± 1.19 and 0.73 ± 0.00) than the lemon seeds (29.66 ± 0.01, 203.16 ± 0.02, 15.63 ± 0.03, 556.27 ± 1.01 and 0.38 ± 0.01) respectively. However, the concentration of copper and iron for the lemon seeds (2.39 ± 0.02 and 2.84 ± 0.01) is higher than that of the peels (1.42 ± 0.00 and 2.11 ± 0.01) respectively. Both the lemon seeds and peels are not poisonous because they contain very less amount of cadmium, manganese, lead, nickel and chromium. Sodium plays a major role in the volume of plasma and in the function of the contraction of muscles and nerves.

Table 1: Mineral composition of *citrus limon* peels and seed extracts (mg/100 g)

Mineral contents	Peels	Seeds
Lead	0.10 ± 0.00	0.07 ± 0.00
Cadmium	0.01. ± 0.00	0.01 ± 0.00
Chromium	0.05 ± 0.00	0.08 ± 0.00
Copper	1.42 ± 0.00	2.39 ± 0.02
Manganese	0.02. ± 0.00	0.01 ± 0.00
Nickel	0.08 ± 0.00	0.15 ± 0.00
Sodium	33.54 ± 0.01	29.66 ± 0.01
Calcium	455.21 ± 3.16	203.16 ± 0.02
Zinc	0.73 ± 0.00	0.38 ± 0.01

Potassium	613.11 ± 1.19	556.27 ± 1.01
Iron	2.11 ± 0.01	2.84 ± 0.01
Magnesium	18.89 ± 0.01	15.63 ± 0.03

Key: ± SD = Standard Deviation n=3

The value of sodium in the lemon peels is higher than that reported by Bampidis and Robinson[11] (30 mg/100 g) for dried orange while the concentration in the seed is less than it. The amount of potassium in the current study is less than that reported by Bampidis and Robinson[11] with value 820 mg/100g. Physiological processes are carried out by potassium in living organisms. Magnesium and calcium plays great roles in the functions of animal bodies. Magnesium is vital in stimulation of enzyme and the balance of acid-base intracellular regulations[12]. Calcium and magnesium are also vital in the strengthening of bone and tooth[13,14]. The values of magnesium and calcium are higher than those reported by Czech, *et al*[15] (9.86 mg/100g and 25.9 mg/100g) for lemon fruits respectively. Iron and copper in the peels and seed of lemon is more than those reported in Czech, *et al*[15] of 0.31 mg/100 g and 0.05 mg/100 g respectively. Iron is used for transporting oxygen during breathing from the lung to cells and tissues and the synthesis of haemoglobin. Copper also helps in red blood cell regulation in animals. It also acts as a catalyst in unsaturated lipids oxidation with ascorbic acid.

Analysis of phytochemicals

The result of the phytochemical screening of the lemon extract as given in table 2 revealed the presence of alkaloids, flavonoids, saponins, phenols, cardiac glycosides and steroids in both the lemon seeds and peels. Terpenoid is only present in the seeds while anthraquinones and phlobatannins were absent in both the lemon seeds and peels.

Table 2: Phytochemical constituents of *citrus limon* peels and seed extracts

Phytochemical	Peels	Seeds
Alkaloids	+	+
Flavonoids	+	+
Saponins	+	+
Phenols	+	+
Tannins	+	+
Terpernoids	+	-
Cardiac glycosides	+	+
Anthraquinons	-	-
Phlobatannins	-	-
Steroids	+	+

The observation of the presence of these phytochemicals in the lemon proves while it is of great medicinal importance. Flavonoids are complex naturally occurring phenolics that have been reported to have anti-diabetic, anti-bacterial, anti-cancer, anti-aging, anti-inflammatory and with enormous cardio-protective properties[16]. Flavonoid acts as free radical scavengers producing anti-oxidative responses chelating with metal ions like copper and iron[17]. Alkaloids also have antibacterial, analgesic and anti-plasmodic properties which make useful for medicinal purpose. Due to the presence of

these metabolites, *citrus limon* seeds and peels can be useful for the treatment of some infections and diseases.

FTIR Spectra

The FTIR spectroscopy is used as a means of predicting and identifying the functional groups or chemical bonds of the lemon peels and seeds. These bonds were resolved by elucidating the spectra of the infrared absorption. Figure 1 and figure 2 give the FTIR spectra of the lemon peels and seeds respectively.

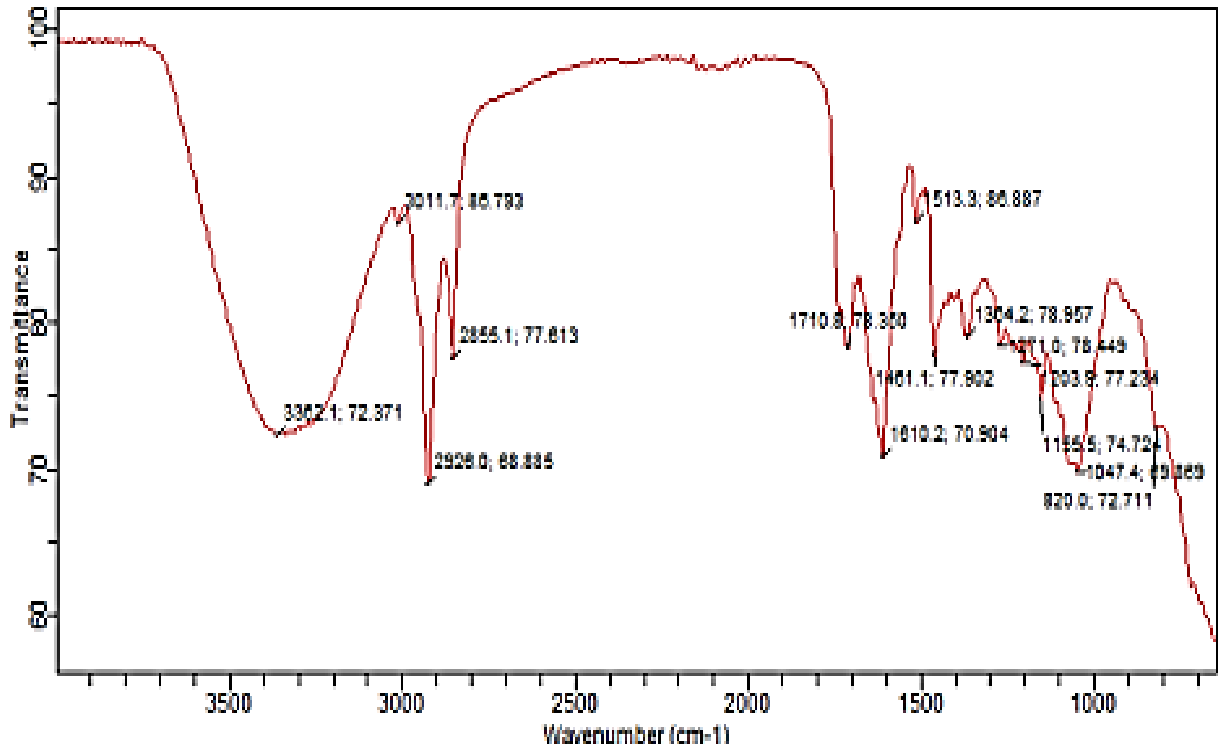

Fig. 1 FTIR Spectrum for lemon peels extract

The spectrometric observation for the lemon peels and seed surfaces was in the range of 4000 – 630 cm^{-1}. The absorption bands at 3362.1 cm^{-1} and 3399.3 $cm^{-1}$for the *citrus limon* peels and seeds respectively may be attributed to the -OH stretching vibrations of hydroxyl groups[18].

Strong bonds were observed at 3011.7 cm^{-1} and 2855.1 cm^{-1} for both the peels and seeds. This could be a CH_2 asymmetry stretching vibrations for lipids and C-H stretching for an alkane respectively[19]. There are other various medium to weak bonds and vibrations which may indicate the presence

of amino acids, alkenes carbon dioxides, phosphorus compounds and essential oils

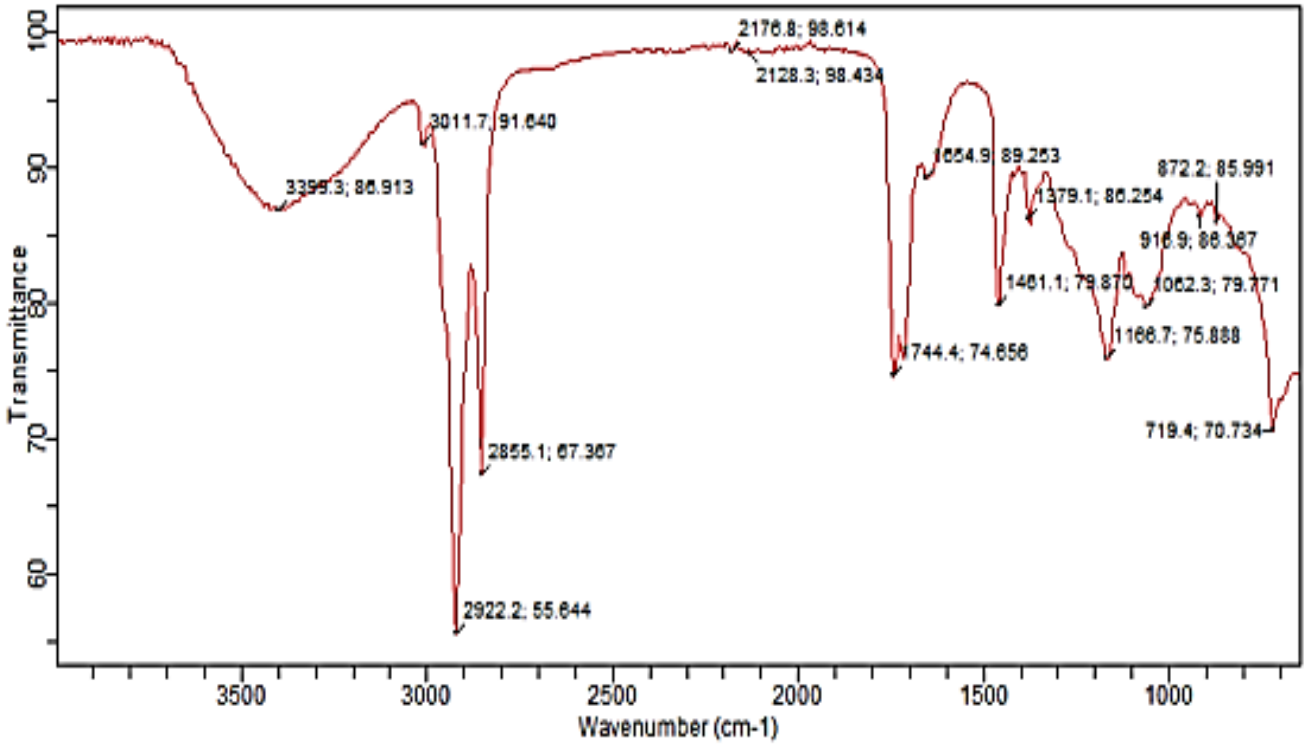

Fig. 2 FTIR Spectrum for lemon seed extracts

Proximate composition

The proximate composition results are shown in table 3. The lemon peels and seeds have moisture content (10.20 ± 0.24 and 7.43 ± 0.11); ash content (13.17 ± 0.10 and 10.07 ± 0.09); crude fat (11.77 ± 0.85 and 9.50 ± 0.37); crude proteins (3.85 ± 0.43 and 5.38 ± 0.39); crude fibre (18.16 ± 0.06 and 15.61 ± 0.51) and carbohydrate (42.85 ± 0.25 and 52.01 ± 0.39) respectively.

Table 2: Proximate composition of *citrus limon* peels and seed extracts (%)

Parameter (%)	**Peels**	**Seeds**
Moisture Content	10.20 ± 0.24	7.43 ± 0.11
Ash content	13.17 ± 0.10	10.07 ± 0.09
Crude fat	11.77 ± 0.85	9.50 ± 0.37
Crude Proteins	3.85 ± 0.43	5.38 ± 0.39

Crude fibre	18.16 ± 0.06	15.61 ± 0.51
Carbohydrate	42.85 ± 0.25	52.01 ± 0.39

The moisture content affects the shelf life of plants. The higher the moisture content the lower the shelf life[20]. The moisture content in the lemon peels is higher than that of the seeds, though both have low moisture which indicates a long shelf-life[21]. Ash content is important in animal diet and has a link to the mineral composition[22]. The more the ash contents the more the possibility of more minerals. The lemon peels is expected to have a higher mineral content than that of the seeds due to its higher ash contents. Both the lemon peels and seeds have a great amount of fibre, indicating that they can be major roughage as feed components. The results of the crude fibre in lemon peels and seeds are higher than that reported by Ülger, *et al*[23] (11.52%) for lemon fruits. The carbohydrate content is high for both the lemon peels and seeds. This means they can be used to provide energy in animals during metabolism[24]. Proteins are important for body building and fixing worn out tissues in animals. The protein content in the lemon peels and seeds are reasonable and could be used as supplements in protein diets. The amount of protein contents in the lemon peels and seeds is less than the amount (14.90%) reported by Luzardo *et al*[25].

CONCLUSION

The study carried out shows that lemon peels and seeds have reasonable amounts of nutritional materials such as carbohydrate, protein and fibre and as supplement in food. They are also very rich in secondary metabolites and minerals which can therefore find use in the production of certain drugs and these seeds and peels that are considered as waste can be utilized in producing feeds for livestock.

REFERENCES

1. Raimondo, M., Caracciolo, F., Cembalo, L., Chinnici, G., Pecorino, B., and Mario D'Amico, M. (2018). Making virtue out of necessity: managing the citrus waste supply chain for bioeconomy applications. *Sustainability* 10, 4821–4840. doi: 10.3390/su10124821

2. UNCTAD (2007). Market Information in the Commodities Area: Citrus Fruit

3. Avello. M, (2014). "Use of Citrus limon l. (lemon) in treating blood pressure sudden rises". *International Journal of Pharmacognosy and Phytochemical Research* 6.3: 606-611.

4. Chaturvedi, D and Shrivastava Suhane, R.R.N (2016). "Basketful Benefit of Citrus Limon". *International Research Journal of Pharmacy*. 11(6): 75-81.

5. Hojjati, M. & Barzegar, H (2017). "Original Article Chemical Composition and Biological Activities of Lemon (Citrus limon) Leaf". *Nutrition and Food Science Research* 4.4: 15-24.

6. Rafiq, S., Kaul, R., Sofi, S. A., Bashir, N., Nazir, F., and Ahmad Nayik, G. (2018). Citrus peel as a source of functional ingredient: a review. *Journal of the Saudi Society Agricultural Science*. 17, 351–358. doi: 10.1016/j.jssas.2016.07.006

7. Zema, D. A., Calabr,ò, P. S., Folino, A., Tamburino, V., Zappia, G., and Zimbone, S. M. (2018). Valorisation of citrus processing waste: a review. *Waste Management* 80, 252–273. doi: 10.1016/j.wasman.2018.09.024

8. Sofowora, A. (1993). Medicinal plants and traditional medicine in Africa. Second Edition. Spectrum books limited, Ibadan Nigeria. Pp 134-234.

9. Trease, G. E. and Evans, W. C. (2002). Pharmacognosy. 15th Edition Saunderss Publishers pp 214-393.

10. AOAC. (1990). Official methods of analysis. 15th Edn., Association of official analytical Chemists, Washington D.C. pp2026.

11. Bampidis, V. A. and Robinson, P. H. (2006). Citrus by-products as ruminant feeds: a review. *Animal Feed Science and Technology*. 128, 175–217. doi: 10.1016/j.anifeedsci.2005.12.002.

12. Beldi, H., Gimbert, F., Maas, S., Scheifier, R., and Soltani, N. (2006). Seasonal variations in Cd, Cu, Pb and Zn in the edible Mollusc donax trunculus from the gulf of Annaba Algeria. *African Journal of Agricultural Research.* 1, 85–90.

13. Kartika, H., Shido, J., Nakamoto, S. T., Li, Q. X., and Iwaoka, W. T. (2011). Nutrient and mineral composition of dried mamaki leaves (Pipturus albidus) and infusions. *Journal Food Composition and Analysis.* 24, 44–48. doi: 10.1016/j.jfca.2010.03.027

14. Ibrahim, N. D. G., Abdulrahman, E. M., and Ibrahim, G. (2001). Elemental analysis of the leaves of Vernonia amydalina and its biological evaluation in rats. *Nigerian Journal of Natural Product and Medicine*. 5, 13–17. doi: 10.4314/njnpm.v5i1.11715.

15. Czech, A., Zarycka, E., Yanovych, D., Zasadna, Z., Grzegorczyk, I., and Kłys, S. (2020). Mineral content of the pulp and peel of various citrus fruit cultivars. *Biological Trace*

Element Research. 193, 555–563. doi: 10.1007/s12011-019-01727-1

16. Neuhouser ML (2004) Flavonoids and cancer prevention: what is the evidence in human? *Pharmaceutical Biology* 42(supplement):36–45.

17. Wang T, Qing L, Bi K (2018) Bioactive flavonoids in medicinal plants; structure, activity and biological fate. *Asian Journal of Pharmaceutical Science* 13(1):12–23. https://doi.org/10.1016/j.ajps,2017.08.004

18. Spectroscopic Tools. Access from http://www.science-and-fun.de/tools/. [Access online 21-25 October 2019]

19. Socrates, G. (2004). Infrared and Raman characteristic group frequencies tables and charts. John Wiley & Sons Ltd, Baffins Lane, Chichester, West Sussex PO19 IUD, England: pp. 1-340.

20. Uyoh, E. A., Chukwura, P. N., David, I. A., and Bassey, A. C. (2013). Evaluation of antioxidant capacity of two Ocimum species consumed locally as spices in Nigeria as a justification for increased domestication. *American Journal of Plant Science.* 4, 222–230. doi: 10.4236/ajps.2013.42029

21. Alagbe, J. O. (2020). Performance, hematology and serum biochemical parameters of weaner rabbits fed different levels of fermented Lagenaria brevifora whole fruit extract. *Advanced. Research. Reviews.*1, 5–15
.

22. Oyeyinka, B. O., and Afolayan, A. J. (2019). Comparative evaluation of the nutritive, mineral, and antinutritive composition of Musa sinensis L. (Banana) and Musa paradisiaca L. (Plantain) *Fruit Compartments. Plants* 8, 598–612. doi: 10.3390/plants8120598

23. Ülger, I., Beyzi, S. B., Kaliber, M., and Konca, Y. (2020). Chemical, nutritive, fermentation profile and gas production of citrus pulp silages, alone or combined with maize silage. *South African Journal of Animal Science.* 50, 161–169. doi: 10.4314/sajas. v50i1.17

24. Olanipekun, M. K., Adewuyi, D., and Adedeji, D. E. (2016). Ethnobotanical importance and phytochemical analyses of some selected medicinal plants in Ado-Ekiti Local Govt. *Journal of Herbal Medicinal. Research.* 1, 7–16.

25. Luzardo, S., Banchero, G., Ferrari, V., Ibáñez, F., Roig, G., Aznárez, V., et al. (2021). Effect of fresh citrus pulp supplementation on animal performance and meat quality of feedlot steers. *Animals* 11, 3338–3341. doi: 10.3390/ani11123338