

Original Research Article

Nutritional value and Amino acid profile of dried

Cucumeropsismannii Seeds

Abstract

Aims: to assess the biochemical, phytochemical and amino acid profile of the flour from dried seeds of *Cucumeropsismannii* grown in Côte d'Ivoire.

Study design: Experimental

Place and duration of study: Sample: Laboratory of Nutrition and Food Security, Nangui Abrogoua University

Methodology: *Cucumeropsismannii* seeds were obtained for this study from an experimental field in Gagnoa (Côte d'Ivoire). In March 2022, seeds were planted and after 7 months, the mature fruits that lead to the complete drying of the plant were harvested.

Results: The biochemical composition of the seeds revealed that they contain varying proportions of carbohydrates, fibers, ash, and total sugars with contents of 9.28 ± 0.79 %; 2.72 ± 0.30 %; 3.12 ± 0.38 ; 2.34 ± 0.05 , respectively. High levels of lipids, proteins, dry matter and energy were observed in seed flour with values of 47.46 ± 1.55 %; 31.80 ± 1.16 %; 94.38 ± 0.6 %; 591.46 ± 1.17 kcal /100 g DM. The resulting flour reached a pH of 6.5. The study of phytochemicals showed varying levels of oxalate (0.32 g/100g DM), tannins (3.02 g TAE/100g DM), total polyphenols (8.12 mg GAE / g DM), total flavonoids (27.5 mg QE/g DM) and carotenoids (2.9 µg/100g DM). Furthermore, they were potential sources of essential amino acids, including histidine (905.6 mg/100g), isoleucine (844.5 mg/100g), threonine (730.1mg/100g), phenylalanine (550.0 mg/100g), valine (469.9 mg/100g), leucine (456.6 mg/100g), and methionine (358.5 mg/100g).

Conclusion: The overall result implies that *Cucumeropsismannii* seeds could be added to the food preparations of malnourished children.

Key words: *Cucumeropsismannii*, phytochemicals, amino acids, lipids, protein

Comment [TS1]: Please mention the complete nomenclature of the plant. « *Cucumeropsismannii*Naudin » The title best written as « **Nutritional value, phytochemical analysis and Amino acid profile of dried *Cucumeropsismannii*Naudin Seeds** »

1. INTRODUCTION

Agriculture is the basis of human development and could be an appropriate solution to the worldwide food shortage, particularly in the developing countries. Today, the recommendations of institutions and organizations, including FAO, for increasing productivity, and the quality of the agricultural sector in developing countries are focused on underutilized crops [1]. These include cucurbit, which are plant high in balanced protein and are cheap compared to animal protein. Indeed, the cucurbitaceae is remarkable plant family

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deserving **of** attention because of its **many sided significances** in economic, cultural, medicinal and **botanical**. In certain cultures, the seeds, leaves, roots are also consumed. **According** some studies, the seeds are rich in lipids, proteins and carbohydrates [2, 3]. Cucurbits were **also** overlooked; however, underutilized plants in Africa were suitable for a wide range of agroecosystems and cropping systems [1]. Investigations by Zoroet *al.* [4] have identified five species of cucurbits in Côte d'Ivoire, including *Cucumeropsis mannii* (*C. mannii*). These seeds known as white-seeded melon, commonly called « n'vièle » in Côte d'Ivoire [4]; come from tropical Africa where they are valued for their oilseeds grown for food and as an oil source. But *Cucumeropsis mannii* seeds are still underexploited due to scientific ignorance about their nutritional potential. This research aims to determine **the** nutritional characteristics of *Cucumeropsis mannii* seeds grown in Côte d'Ivoire.

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Comment [TS8]: The complete name of the plant *Cucumeropsis mannii* should be mentioned once at the first time in the article, then keep using (*C. mannii*) for the rest of the paper

Comment [TS9]: Add : « the phytochemical contents » and nutritional

2. MATERIAL AND METHODS

2.1. vegetable material

The biological material for this study was *Cucumeropsis mannii* seed which **come** from an experimental field in the locality of Gagnoa (Côte d'Ivoire).

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2.2. Preparation of **simples**

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Cucumeropsis mannii was harvested at leaf wilt to indicate fruit maturity and ripening. The latter underwent a hemispherical cut and were left to decompose for one or two weeks until the pulp softened to facilitate the extraction of the seeds. The seeds were then separated from the fruit pulp, washed with water and dried in the oven at 45°C for 3 days. They were manually peeled and the almonds were finely ground to obtain powders that **will be sieved** (250 µm **diamater**) and put in plastic bags for storage before the analysis tests.

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2.3. Chemical Analysis

The pH of the dried seed powder was determined according to the method described in AOAC [5]. The AOAC method [6] was used to determine the moisture content after drying at 105°C for 24 **hours** to constant weight and the total ash content was determined by incinerating in a 550°C furnace. The AOAC method [6] was again used to determine crude fiber, and fat extraction in a Soxhlet apparatus for 8 **hours** using hexane for the determination of lipid content; while Nitrogen was done by Kjeldahl method and crude protein content subsequently calculated by multiplying the nitrogen content by a factor of 6.25. Ethanol-soluble sugars from *Cucumeropsis mannii* powder were extracted using the technique

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described by Martinez-Herrera et al., [7]; then. Total sugars were determined by Dubois *et al.* [8] using phenol and sulphuric acid. Available carbohydrate levels were determined using the difference method described by FAO [9] as following:

Total carbohydrate (%) = 100 % - [(%)moisture + (%) protein + (%) fat + (%) fibre + (%) ash)]

The theoretical energy value was determined using the method outlined by Atwater and Rosa [10] from the specific coefficients for proteins, lipids and carbohydrates as following:

Energy value (Kcal/100g DM) = 4 x (%) protein + 9 x (%) lipids + 4x (%) carbohydrates

2.4. Antinutrients Analysis

Tannin were determined as reported by Bainbridge *et al.* method [11]. The principle of the assay is based on the fact that tannic acid in the presence of vanillin (0.1 mg/mL) and 70% of sulphuric acid gives a red coloration when the absorbance was measured at 500 nm. The tannins content of *C. mannii* was expressed as tannic acids equivalent (TAE). while oxalate and carotenoids were defined as indicated by AOAC [6] and FAO [12], respectively. Total polyphenols were measured according to Makkar *et al.*, [13]; Cicco *et al.*, [14] using the Folin Ciocalteu reagent. The absorbance is measured at 725 nm in the spectrophotometer and the results of polyphenol content were subsequently calculated as Gallic acid equivalent (GAE). As for flavonoids, they were determined as described by Meda *et al.* [15] using Quercetin as standard. The absorbance was measured at 415 nm; then flavonoid content of *C. mannii* was expressed as Quercetin equivalent (QE).

2.5. Amino acid analysis

The amino acid composition of sample was determined using a high-performance liquid chromatograph (HPLC), Applied Biosystems Model 172 A (Applied Biosystems, Foster City, California, USA) equipped with a RP-18 PTC column (2.1mm 22cm). Prior to injection, the proteins in sample were previously hydrolyzed by HCL 6 M with phenol (1%) at 150°C for 60 minutes in the Pico-Tag system (Waters, Milford, Mass., U. S.A.) The amino acid phenylisothiocyanate derivatives obtained were eluted by HPLC. Sodium acetate (105Mm, PH 4.6; 30%) and acetonitrile (70%) were used as elution buffers. A calibration chromatogram was established for the standard available amino acids.

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2.6. Statistical analysis

All measurements were carried out in triplicate. Differences between means were separated using Student test with the least significance difference fixed at 0.05. Statistical analysis of the data was performed using Statistical version 7.1 software package.

3. RESULTS AND DISCUSSION

3.1. Proximate composition

The proximate composition of *Cucumeropsismannii* seed flour was shown in table 1. The percentage protein of $31,80 \pm 1,16$ was comparable to the value reported for melon seeds (31.1 %) and squash seeds (33.0 %) [16] but lower than the results of *C. mannii* seeds (37.4-37.9 %) in Nigeria [17, 18]. Studies proved that, proteins were essential macronutrients for humans, with a key role in building and repairing the body [19]. The crude fibre of *C. mannii* seed (2.72 %) in this study was similar than those reported by Ogunbusola *et al.*, [17] and peanut seeds [20]. Adequate intake of crude fiber might have a helpful physiological role such as low incidence of colon cancer [21]. However, this low fibre content of powders from *Cucumeropsismannii* seeds suggests that it would not be sufficient to meet the estimated human fibre needs of 14.2-17.5 g/day [22]. As a result, it should be combined with other fiber-rich dietary sources to prevent various chronic diseases [23]. The moisture content of *C. mannii* seed ($5.62 \pm 0,6$ %) was also similar to $5.53 \pm 0,35$ % [17], for *C. mannii* in Nigeria and previously comparable to $5.01 \pm 0,01$ reported by Mohaammed *et al.*, [24]) in *Cucurbita maxima*. This low moisture content showed that the quality of this powder could protected it against the development of microorganisms. Indeed, according to Aryee *et al.* [25], the moisture content is a very important parameter in the storage of flours, since a moisture content greater than 12 % would promote the growth of microorganisms. *Cucumeropsismannii* powder showed a slightly acidic pH of 6.50, which certifies that the powder could be stored for as long without risk of deterioration. With respect to the lipid content of *C. manni* seeds, studies indicated a relatively high level (47.46 %) comparable to those reported by Ogunbusola *et al.* [17] ($45.06 \pm 1.25 - 48.57 \pm 0.76$ %). Thus, *C. mannii* seeds could be classified as oilseeds that can be used as a source of vegetable oil for industrial and domestic purposes. The ash content (3.12 ± 0.38 %) was lower for the values reported for *Benincasa hispida* seeds (5.02- 11.81 %)[26] but similar to *M. oleifera* seeds (3.5 %) [18]. Therefore, *Cucumeropsismannii* seeds could provide minerals essential to the proper functioning and development of the body. Concerning available carbohydrates content (9.28

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± 0.79 %), the rates investigated in this study were higher than those of *C. manni* (5.7 %) [18]) of the Congo and *C. ecirrhosus* seeds (18.69 ± 0.82 %) from Nigeria [27]. The energy value of *Cucumeropsismannii* powder (591.46 ± 1.17 Kcal/ 100 g DM) was comparable with *C. ecirrhosus* seeds (601.7 Kcal/100g) [27]; almost lower to that of peanut paste (626 Kcal/100g) [28]; but higher with those reported for *Cucurbita maxima* (438.84 ± 0.07 Kcal/100g DM) [24] in Nigeria. The low level of total sugars (2.34 ± 0.05 %) observed was similar to that of *Citrullus lanatus* (2.23 %) from N'guetta *et al.*, [29]. This suggests that *Cucumeropsismannii* powder is a poor source of total sugars.

Table 1: proximate analysis of *Cucumeropsismannii* seeds flour

Parameter	values
Moisture (%)	5.62 ± 0.60
pH	6.50 ± 0.00
Ashes (%)	3.12 ± 0.38
Protein (%)	31.80 ± 1.16
Lipids (%)	47.46 ± 1.55
CrudeFiber (%)	2.72 ± 0.3
Carbohydrates (%)	9.28 ± 0.79
Total sugars (%)	2.34 ± 0.05
Energyvalue (Kcal/100g DM)	591.46 ± 1.17

Values represent the mean ± standard deviation of three measurements (n = 3)

3.2. Phytochemical compound

Table 2 shows the result for the anti-nutrient composition of *Cucumeropsismannii* flour seeds. The total polyphenols in *Cucumeropsismannii* powder (8.12 mg/g) in this study were lower than those of *Cucumeropsismannii* (0.39 %) [30] in Cameroon. High polyphenols could increase the chelation capacity of these phenols and make nutrients and minerals in particular unavailable. Tannins have anti-oxidant properties, antimutagenic and anti-cancer activities [31].

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The tannin content of *Cucumeropsismannii* powder (3.02 g/100g) was higher than those reported by Ogunbusola *et al.*, [17] with *Cucumeropsismannii* (15.4 mg/100g) and *Cucumeropsis edulis* (4.69-29.11 mg EC/100g DM) obtained by Yété *et al.*, [32]. However, they remain well below the recommended limit values of 1 mg/100 g DM, which influence protein bioavailability [33]. According to Kataria *et al.*, [34], heat treatments of cooking reduce the level of tannins and denature insoluble tannin-nutrient complexes. A research by Gülçinet *et al.*, [35] opined that tannins provided neuroprotective, cardioprotective and even antitumoral activities. Levels of flavonoids in this study were also lower than *Cucurbita maxima* (46.05 %) and *Citrullus lanatus* (41.57 %) seeds [36]. This concentration of flavonoid powder from *Cucumeropsismannii* could protect the body from oxidative stress-related diseases, coronary artery disease and cancer [37]. The carotenoid (2.9 µg/100g DM) content was lower than the value recorded by Okorie [38] in white melon seed flour (Nigeria). It implies that the flour of *Cucumeropsismannii* can reduce the risk of cardiovascular disease [39].

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Table 2 : Anti-nutrients composition of *Cucumeropsismannii* seeds flour

Parameter	Values
Flavonoïdes totaux (mg QE/g DM)	27.51 ± 0.03
Polyphénols totaux (mg GAE/g DM)	8.12 ± 0.09
Tanins (g TAE/100g DM)	3.02 ± 0.80
Oxalates (g/100g DM)	0.32 ± 0.02
Caroténoïdes (µg/100g DM)	2.9 ± 0.11

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Values represent the mean ± standard deviation of three measurements (n = 3); DM: dry matter; Quercetin equivalent (QE); Gallic acid equivalent (GAE); tannic acids equivalent (TAE)

3.3. Amino acid profiles

The amino acid content for *Cucumeropsismannii* seeds flour (table 3) indicated that histidine, leucine, isoleucine, methionine; phenylalanine, threonine, valine, aspartate, alanine, glycine, acide glutamate, tyrosine, serine and arginine were presents. In addition, the amino acids profile of *Cucumeropsismannii* seeds flour showed that it contained both essential and non-essential amino acids; which would confirm that these proteins were of high quality. However, lysine has not been identified. Results have shown that aspartic acid (968.1mg/100g) was the most abundant of non- essential amino acids in melon seeds flour;

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while histidine (905.6 mg/100g) was the most abundant essential amino acids. the findings were similar to those of some authors who suggest that aspartic acid and glutamic acid were the most abundant amino acids in legume and nuts [40]. Essential amino acids were known for their significant physiological role in childhood growth [41]. Indeed, the proportion of arginine and histidine and over amino acids indicated that the seeds of *Cucumeropsismannii* may be useful in formulating weaning food [42]. Some amino acids, such as phenylalanine, leucine, aspartate, serine, arginine and tyrosine, have been said to have anti-sickling properties [43]. Researchers further explained that the anti-sickling effect of certain amino acid such as phenylalanine may be as a result of its anti-oxidative effects and also its ability to remove free radicals [44]. Results from this study would confirm that *Cucumeropsismannii* proteins includes a significant proportion of essential amino acids. They could address children's and adult's protein needs in both developed and developing countries.

Table 3: amino acids composition of *Cucumeropsismannii* seed flour

Aminoacid	Values (mg/100g)
Histidine	905.6 ± 0.03
Isoleucine	844.5 ± 0.11
Leucine	456.6 ± 0.01
Méthionine	358.5 ± 0.04
Phénylalanine	550.0 ± 0.10
Thréonine	730.1 ± 0.02
Valine	469.9 ± 0.05
Asparticacid	968.1 ± 0.06
Alanine	840.3 ± 0.32
Glycine	787.3 ± 0.22
Glutamicacid	771.3 ± 1.12
Tyrosine	769.4 ± 0.14
Serine	617.7 ± 0.27
Arginine	254.2 ± 0.33
Total essential aminoAcids (ΣEAA)	616.45 ± 0.05
Total non Essential aminoAcids (ΣNEAA)	715.47 ± 0.32

Values represent the mean \pm standard deviation of three measurements ($n = 3$)

4. CONCLUSION

Cucumeropsis mannii seeds investigated in this study contained high percentage of nutrients such as proteins and lipids making them a good source of energy for human nutrition. The result of this finding also showed appreciate quantities of tannins, flavonoids and polyphenols. In addition, the presence of affordable quantities of tannins and carotenoids, would represent a major nutritional asset because of their antioxidant power. However, *C. manni* seeds contained also a valuable source of essential amino acids that could provide important health benefits. It might be appreciated for animal and human nutrition.

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Statement of informed consent

Every participant in the study gave their informed consent.

REFERENCES

1. Williams, J.T., & Haq, N. 2002. Global research on underutilized crops. An assessment of current activities and proposals for enhanced cooperation. ICUC, Southampton, UK. 54 pages
2. Badifu GIO. 2001. Effect of processing on proximate composition, antinutritional and toxic contents of kernels from cucurbitaceae species grown in Nigeria. Journal of Food Composition and Analysis, 14: 153-161.
3. GrodjiAlbarinGbogouri, Kouakou Brou, Michel Linder, Elmira Arab TEHRANY, Dago Gnakri&Irié Arsène Zoro BI, 2011. Comparative study of physicochemical and thermal properties of the seed oils of three cucurbit species. International Journal of Biological and Chemical Sciences 5(3): 1165-1177
4. Zoro Bi I, Koffi KK, Djè Y, Malice M., &Badoin JP. 2006. Indigenous cucurbits of Côte d'Ivoire: a review of their genetic resources. Science & Nature, 3(1): 1-9.
5. AOAC., (2000). Official Methods of Analysis of Association of Official Analytical Chemists. 17th ed. Gaithersburg, Maryland, USA.
6. AOAC (Association of Official Analytical Chemists)., (1990). Official Methods of Analysis Association of Official Analytical Chemists. K. Helrich (ed). Fifteenth edition. Virginia (USA), 963-964.

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7. Martínez-Herrera J, Siddhuraju P, Francis G, Dávila-Ortíz G., & Becker K. (2006). Chemical composition, toxic/antimetabolic constituents, and effects of different treatments on their levels, in four provenances of *Jatropha curcas*L. from Mexico. Food Chemistry 96, 80-89.
8. Dubois M.N., Gruillies K.A, Hamilton J.K., Rogers P.A.,& Smith F. (1956). Colorimetric method for determination of sugars and related substances. Analytical Chemistry; 28: 350-356
9. F.A.O (2002). Food energy-methods of analysis and conversion factors. Food and nutrition, Paper 77, 93p
10. Atwater W., & Rosa E. (1899). A new respiratory colorimeter and the conservation of energy in human body, II. *Physical Review*, 9: 214-251.
11. Bainbridge Z, Tomlins K, Wellings K., & Westby A. (1996). Methods for assessing quality characteristics of non-grain starch staples (Part 3, laboratory methods) Chatham, United Kingdom Natural Resources Institute. 1996; 34-39
12. FAO/IAEA. (2000). Quantification of tannins in tree foliage. A Laboratory Manual. Website : <http://www.iaea.org/programmes/nafa/d3/index.html>.
13. Makkar H.P.S., Blümmel M., Borowy N.K., &Becker K. (1993). Gravimetric determination of tannins and their correlations with chemical and protein precipitation methods. Journal. Science. Food Agriculture., 61: 161–165.
14. Cicco N., Lanorte T. M., Paraggio M., Viggiano M., &Lattanzio V. (2009). A reproducible rapid and inexpensive Folin-Ciocalteu micro-method in determining phenolics of plant methanol extracts. Microchemical Journal, 91 (1), 107-110.
15. Meda A., Lamien C.E., Romito M., Millogo J., &Nacoulma O.G. (2005). Determination of the total phenolic, flavonoïd and proline contents in Burkina Faso honeys as well as their radical scavenging activity. Food chemistry, 91: 571-577.
16. Olaofe O., Adeyemi F.O., &Adediran G.O. (1994). Amino acid and mineral composition and functional properties of some oils seeds. Journal. Agriculture. Food Chemistry. 42: 878-884

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17. Ogumbusola E.M., Fagbemi N.T., & Osundahunsi O.F. (2012). Chemical and functional properties of full fat and defatted white melon (*Cucumeropsismannii*) seed flours. *Journal of Food Science and Engineering* 26, 691-696.
18. Ntalani H., Ngouanou R. D., Makomo H., Elouma N. A. M., Boungou-T.G., Loumouamou A. N., Mouloungui Z., & Ouamba J-M. (2020). Comparative studies of the chemical composition and coagulant activity of the seeds of *Cucumeropsismannii* Naud., *Arachis hypogaea* L. and *Moringa oleifera* Lam. in the clarification of surface waters. *Journal of Applied Biosciences* 145: 14974 – 14984
19. Ponka R., Nankap E.L.T., Tambe S.T., & Fokou E. (2016). Nutritional composition of some artisanal infant flours from Cameroon. *International Journal of Innovation and Applied Studies*, 16(2): 280 – 292.
20. Knoden J., Dufour L.C., & Bindelle J. (2011). Manufacture of Peanut Butter. Draft. « Technical Manuals » Collection. P3-4.
21. Sanchez-Castillo C.P., P.J.S Dewey, J.J. Lara, D.L. Anderson, M.L. Solano, & W.P.T. James, 2000. The starch and sugar content of some mexican cereals products, pulses, snack food fruits and vegetables. *J.Food Comp. Anal.*, 13 : 157 -170
22. Saada A.D., Chabane A.O., Bouderoua K., & Selselet A.G. (2016). Role of pulses in human nutrition – nutritional strengths and health impacts. Regional Forum for the Development of Food Legumes – University of Mostaganem, 5p.
23. Rémond D., & Walrand S. (2017). Legume seeds: nutritional characteristics and health effects. *Agronomic Innovations, INRA*, 60, pp. 133-144.
24. Mohaammed S.S., Paiko Y.B., Mann A., Ndamitso M.M., Mathew J.T., & Maaji S. (2014). Proximate, Mineral and Anti-nutritional. Composition of *Cucurbita Maxima* Fruits Parts, *Nigerian Journal of Chemical Research*, 19: 37-49.
25. Aryee FNA, Oduro I, Ellis WO, & Afuakwa JJ. The physicochemical properties of flour samples from the roots of 31 varieties of cassava. *Food control*. 2006; 17: 916- 922.
26. Anwar F., Mohammad N.A., Othman F., & Saarii N., (2011). Inter-varietal variation in the composition of seeds and seed oils from winter melon (*Benincasa hispida*(Thumb) Cogn.) fruit. *Pakistan Journal of Botany*. 43, 2029-2037.

27. Umar K.J., Hassan L.G., Usman H., & Wasagu R.S.U. (2013) Nutritional composition of the seeds of Wild melon (*Citrullusecirrhosus*). *Pakistan journal of Biological science* 16(11) : 536-540
28. Ciqal 2017. Food Nutrition Composition Table. Retrieved on 16-08-2022 from <https://www.ANSES.fr>
29. N'guetta A.M.N. (2016). Agro-morphological and nutritional characteristics of the cultivars of *Citrullus lanatus* (Cucurbitaceae) grown in Côte d'Ivoire and use of their meal in broiler production (*Gallus gallus*). Thesis for the title of Doctor in Biochemistry and Food Technology of NanguiAbrogoua University (Côte d'Ivoire), 260p.
30. Achu M.B., Fokou E., Kamcsi G., & Fotso M., (2013). Chemical evaluation of protein quality and phenolic compound levels of some cucurbitaceae oil seeds from Cameroun. *African journal of biotechnology*. 12(7): 735-743.
31. Maisetta G., Batoni G., Caboni P., Esin S., Rinaldi A.C., & Zucca P. (2019). Tannin profile, antioxidant properties, and antimicrobial activity of extracts from two Mediterranean species of parasitic plant *Cytinus*. *BMC complementary and alternative medicine* 19 (82) :1-11
32. Yété P., Togbé A., Yaya K., Agbangnan P., Vital N., Djèntonin T. S., D Wotto D., Azandégbé E.C., & Sohounhloue D. (2015). Comparative study of phenolic compounds and radical-scavenging activity of the extracts of seeds of *Garcinia kola* (Guttiféreae) and *Cucumeropsis edulis* (cucurbitacéae) of Benin. *International Journal of Innovation and Scientific Research*, 15 (1) : 217-227
33. Li H. Wang Z., & Liu, Y. (2003). Reviews in the studies on tannins activity of cancer prevention and anticancer. *Zhong-Yao-Cai*, 26(6) : 444-448.
34. Kataria A., Chauhan B.M., & Punia D. (1989). Antinutrients and protein digestibility (in vitro) of mungbean as affected by domestic processing and cooking, *Food Chemistry* 32: 9-17 pp.
35. Gülçin L, Huyut Z, Elmasta M, & Aboul-Enein HY. Radical scavenging and antioxidant activity of tannic acid. *Arab J Chem*. 2010; 3:43-53.

36. Karaye U.I., Alero A.A., Muhammad S., & Bilbis L.S. (2013). Evaluation of nutrient and antinutrient contents of selected Nigerian cucurbits seeds. *Research journal of pharmaceutical, Biological and Chemical Sciences*, 4(1), 137-142.
37. Knekt, P.; Kumpulainen, J.; Järvinen, R.; Rissanen, H.; Heliövaara, M.; Reunanen, A.; Hakulinen, T., & Aromaa, A. (2002). Flavonoid Intake and Risk of Chronic Diseases. *Am. J. Clin. Nutr.*, 76, 560–568.
38. Okorie Peter Anyigor (2018). Determining the physiochemical and phytochemical properties of local Nigerian white melon seed flour. *International journal of research Granthaalayah*, 6(5) : 157-166
39. Schunemann, H. J., McCann, S., Grant, B. J. B., Trevisan, M., Muti, P., & Freudenheim, J. L. (2002). Lung function in relation to intake of carotenoid and other antioxidant vitamins in a population-based study. *American Journal of Epidemiology*, 155(5), 463–471
40. Olagunju A.I. & Ifesan B.O.T. (2012). Changes in nutrient and antinutritional contents of sesame seeds during fermentation. *Journal of Microbiology, Biotechnology and Food Sciences*, 2 (6) 2407-2410
41. Parikh P., Semba R., Manary M. Swaminathan S., Udomkesmalee E., Bos R., Poh K.B., Rojroongwasinkul N., Geurts J., Sekartini R., & Nga T.T. (2021). Animal source foods, rich in essential amino acids, are important for linear growth and development of young children in low- and middle-income countries. *Maternal and child Nutrition* 18: 1-12
42. Olagunju A.I., & Ifesan B.O.T. (2013). Changes in nutrient and antinutritional contents of sesame seeds during fermentation. *Journal of Microbiology, Biotechnology and food sciences*, 2 (6) 2407-2410
43. Nwaoguikpe RN, & Ejele E.A (2010) Amino acid profile of some antiscikling plant extracts and their haemoglobin polymerization inhibition. *Nig J Biochem Mol Biol* 25(2):53-59
44. Dean J., & Schechter A.N. (1978) Sickle cell anemia: molecular and cellular basis of therapeutic approaches. *N Engl J Med* 229:753–755

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UNDER PEER REVIEW