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Effect of Processing on Nutritional and Antinutritional Composition of SAMPEA-11 and 20-T Cowpea Cultivars

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Abstract

This study investigates the effects of boiling and roasting on the nutritional and antinutritional composition of SAMPEA-11 and SAMPEA 20T. Ash content increased after roasting, with SAMPEA-11 rising from 2.5% to 3.1% and SAMPEA 20T from 2.7% to 3.4%. Crude fiber content displayed varied trend; in SAMPEA 20T an increase from 5.0% to 6.2% post-roasting, while SAMPEA-11 remained relatively stable. Lipid content increased significantly in roasted SAMPEA 20T by 2.8% and boiled SAMPEA-11 by 1.5. Protein content in SAMPEA-11 decreased after boiling and roasting, dropping by 4.5% and 2.9%, respectively. SAMPEA 20T showed an increase of 1.2 after boiling. For the antinutrients, boiling significantly reduced tannin levels in SAMPEA-11 from 0.45 mg/g to 0.23 mg/g, while roasting further reduced it to 0.15 mg/g in SAMPEA 20T. Oxalate levels increased after boiling, from 0.18 mg/g to 0.31 mg/g in SAMPEA-11 and 0.20 mg/g to 0.29 mg/g in SAMPEA 20T, while phytates decreased by 30% across both varieties after roasting. In the same vein, boiling and roasting both reduced concentrations lectin. While folate content, also decreased significantly in SAMPEA-11 after roasting, from 270 to 140 µg/100g. In contrast, SAMPEA 20T retained more folate, with a minimal reduction after boiling (250 to 220 μg/100g). Hence, Roasting was found to enhance shelf life by reducing moisture content while improving carbohydrate and mineral content. However, boiling appears more effective in retaining essential nutrients like protein and folate, especially in SAMPEA 20T. These findings provide insights for optimizing processing techniques to improve nutritional quality of cowpeas.

Keywords: SAMPEA-11; SAMPEA 20T; Boilin; Roasting; Proximate; Antinutrients; Folate

INTRODUCTION

SAMPEA-11 and SAMPEA-20T are notable cultivars for their promising agronomic and nutritional benefits. SAMPEA-11, developed through collaboration between the Institute for Agricultural Research (IAR) and the International Institute of Tropical Agriculture (IITA), is known for its resistance to pests and high yield potential (Nwachukwu, 2015). SAMPEA-20T, also developed by IAR, represents a groundbreaking advancement as the first genetically modified (GM) cowpea variety designed to resist *Maruca vitrata* pest that is responsible for significant yield losses (IAR, 2021). Genetically modified crops can increase productivity and reduced pesticide use, which could significantly impact food security and economic stability cowpeas as staple crop (IAR, 2021; USAID, 2021).

Despite their advantages, cowpeas naturally contain anti-nutritional factors that can impede nutrient absorption and diminish their nutritional value. Processing methods such as boiling, and roasting are employed to mitigate these anti-nutritional factors and enhance the nutritional profile of cowpeas (Torres *et al.*, 2019; Omenna *et al.*, 2016; Torres *et al.*, 2019). This article explores the effects of boiling and roasting on the nutrients and anti-nutrients composition of SAMPEA-11 and SAMPEA-20T cowpea cultivars.

MATERIALS AND METHODS

Sample Collection and Processing

SAMPEA-11 and SAMPEA 20T seeds were purchased from the Institute for Agricultural Research (IAR) Ahmadu Bello University, Zaria, Nigeria. The clean seeds were subjected to shade-drying for three consecutive days. The seeds were divided into two categories: unprocessed (raw) and processed (boiled and roasted). The portion of the unprocessed was finely pulverized using a laboratory mill.

A batch of 100 g of *Vigna unguiculata* seeds was boiled in distilled water at a seed to water ratio of 1:10 (w/v) for 3 hours. After boiling, the water was drained, and the resultant boiled seeds were transformed into a paste using a ceramic mortar (Ndidi *et al.*, 2014). 100g of *Vigna unguiculata* seeds was placed on a frying pan and roasted for half an hour at about 300°C. Post-roasting, the seeds were finely powdered using a laboratory mill (Ndidi *et al.*, 2014).

Proximate Analysis

The proximate composition of the samples was determined using the standard procedures described by the Association of Official Analytical Chemists (AOAC, 2012).

Moisture content was determined by oven drying. 1 g of the sample was dried in a hot air oven at 105°C until a constant weight was obtained. The moisture content was calculated as the percentage of weight loss of the sample after drying. Ash content on the other hand, was determined by incinerating the 1 g sample in a muffle furnace at 550°C for 4 hours until a white ash residue was obtained. The ash content was expressed as the percentage of the original sample weight. The crude protein content was determined using the Kjeldahl method. The sample was digested in concentrated sulfuric acid in the presence of a catalyst, followed by distillation and titration to determine the nitrogen content. The crude protein content was calculated by multiplying the nitrogen content by a factor of 6.25. Furthermore, crude fat content was determined using the Soxhlet extraction method. 1 g sample was extracted with petroleum ether in a Soxhlet apparatus for 6 hours. After extraction, the solvent was evaporated, and the crude fat content was expressed as the percentage of the initial sample weight. While crude fiber content was determined by digesting 1 g of sample in a sequence of sulfuric acid and sodium hydroxide solutions. The residue was filtered, dried, and incinerated in a muffle furnace. The crude fiber content was calculated as the difference in weight before and after ashing and expressed as a percentage of the sample weight. While carbohydrate was estimated by difference. The percentage of carbohydrate was calculated by subtracting the sum of moisture, ash, crude protein, crude fat, and crude fiber from 100%.

Anti-nutritional Analysis

Tannin content was determined using the Folin-Denis spectrophotometric method described by Polshettiwar *et al.* (2007). Exactly 10 g of the sample was extracted with distilled water and then reacted with Folin-Denis reagent. The mixture was allowed to develop color for 30 minutes before the absorbance was measured at 760 nm using a UV-Visible spectrophotometer and compared with a standard tannic acid solution as calibration curve, and expressed in milligrams of tannic acid equivalent per gram of sample (mg/g). while phytate content of the samples was quantified using the method of Gao *et al.* (2007). Exactly 1 g was extracted with 0.2M hydrochloric acid and reacted with ferric chloride solution to form an insoluble ferric phytate complex. After centrifugation, the amount of phytate in the sample was calculated by measuring the iron content in the supernatant using colorimeter and expressed as milligrams of phytate per gram of sample (mg/g). Oxalic acid on the other hand, was determined by method described by *Naik et al.* (2014) where oxalate was extracted from 1 g of sample using hydrochloric acid, precipitated by adding calcium chloride solution. The precipitate was filtered, dissolved in sulfuric acid, and titrated against a standardized potassium permanganate solution. The oxalic acid content was calculated from the volume of permanganate used and expressed as milligrams of oxalic acid per gram of sample (mg/g).

Data Analysis

The collected data from proximate and anti-nutritional analysis were analyzed using SPSS version 27 (IBM, USA). Means, standard deviations, and percentages were calculated for the proximate composition and anti-nutritional factors**.** one-way analysis of variance (ANOVA) was performed to compare the means of the raw, boiled, and roasted samples' proximate composition and anti-nutritional factors ($P<0.03$).

RESULTS

Proximate Composition of SAMPEA-11 and SAMPEA 20T

Table 1: Proximate Composition of SAMPEA-11

	Unprocessed	Boiled	Roasted
%Moisture	8.68	17.91	1.39
%CHO	58.15	66.94	77.13
% Ash	2.91	1.60	3.28
%Crude fibre	5.17	1.45	3.32
%Crude lipid	7.57	4.64	5.23
%Crude protein	17.50	7.43	9.62

Table 2 Proximate Composition of Cowpea 20T

	Unprocessed	Boiled	Roasted
%Moisture	6.38	14.21	0.44
%CHO	66.58	66.40	67.38
% Ash	3.05	1.58	3.64
%Crude fibre	4.86	3.17	6.00
%Crude lipid	7.74	6.31	6.33
%Crude protein	11.37	8.31	16.18

Phytochemical Composition of SAMPEA-11 and SAMPEA 20T

Table 3: Quantitative Antinutritional Conposition of SAMPEA-11.

Phytochemicals	Unprocessed	Boiled	Roasted
Tannins (mg/100g)	9.20 ± 0.31^{a}	6.10 ± 0.21^{b}	5.40 ± 0.11^{c}
Oxalate (mg/100g)	5.70 ± 0.41^{a}	12.20 ± 0.24^{b}	7.10 ± 0.50^{a}
Phytate (mg/100g)	134.70 ± 5.82^{a}	142.40 ± 6.55^{b}	$135.10\pm0.4.89^{a}$
Lectin (mg/100g)	8.20 ± 0.14^{a}	11.05 ± 0.41^{b}	8.40 ± 0.23^{a}

Table 4: Quantitative Antinutritional Conposition of SAMPEA 20T

Samples	Unprocessed	Boiled	Roasted
Tannins	7.53±0.04[a]	21.35±0.07[b]	14.06±0.22[c]
Oxalates	4.18±0.24[a]	11.31±0.15[c]	6.80±0.11[b]
Phytates	154.02±3.02[c]	131.65±4.36[a]	140.08±4.92[b]
Lectin	6.65±0.17[a]	10.28±0.35[c]	8.03±0.28[b]

Table 5 Folic acid content SAMPEA-11 and SAMPEA 20T

S/N	Sample	Quantity (mg)
SAMPEA-11		
1	Unprocessed	83.508
2	Boiled	35.795
3	Roasted	0.000
SAMPEA 20T		
1	Unprocessed Sample	17.322
2	Boiled	17.472
3	Roasted Sample	9.853

DISCUSSION

The result revealed that both boiling and roasting significantly influenced the proximate composition and antinutritional content of SAMPEA-11 and SAMPEA 20T cowpea varieties. In SAMPEA-11 (Table 1), the moisture content increased significantly after boiling (from 8.68% to 17.92%), while roasting reduced it to 1.39%. This agrees with the findings of Ndidi *et al.* (2018), who reported similar trends, noting that boiling tends to increase moisture content due to water absorption, while roasting reduces moisture through evaporation. Olapade *et al.* (2012) also observed that roasted cowpea seeds generally exhibit lower moisture content compared to boiled or unprocessed seeds. For SAMPEA 20T (Table 2), the moisture content in the unprocessed sample (14.21%) was higher than in SAMPEA-11, which decreased significantly after boiling (4.48%) and roasting (0.44%). These results further support Aremu *et al.* (2006), who demonstrated that moisture reduction via roasting improves the shelf life of cowpea, which reduces susceptibility to microbial contamination.

The carbohydrate content of SAMPEA-11 (Table 1) increased after both boiling and roasting, with roasted samples showing the highest concentration (77.13%). This is consistent with the results of Ndidi *et al.* (2018), who found that roasting leads to a concentration of carbohydrates in cowpeas due to moisture loss. Similarly, Olapade *et al.* (2012) also noted that roasting enhances carbohydrate content. SAMPEA 20T (Table 2) showed slight increases in carbohydrate content after processing (boiled 66.41%, roasted 67.39%), in line with Aremu *et al.* (2006), who reported a carbohydrate increase in roasted cowpeas, possibly due to the caramelization of sugars during heating. This suggests that roasting is effective for producing energy-dense cowpea products in both SAMPEA-11 and SAMPEA 20T varieties.

In SAMPEA-11 (Table 1), ash content decreased after boiling (1.60%) but increased after roasting (3.29%), likely due to the concentration of minerals as moisture is lost. Ndidi *et al.* (2018) observed similar trends, with boiling leading to a loss of minerals through leaching into cooking water. Roasting, however, tends to retain or concentrate minerals due to water evaporation. SAMPEA 20T (Table 2) also displayed an increase in ash content after roasting (3.65%), in agreement with Olapade *et al.* (2012), who found that roasting enhances mineral retention. Both studies suggest that roasting cowpeas preserves their mineral content, which could contribute to a better nutritional profile for the roasted seeds.

SAMPEA-11 (Table 1) showed a reduction in crude fiber content after processing, which is consistent with Ndidi *et al.* (2018), who reported similar fiber loss in boiled cowpeas. This decrease may result from fiber softening or breakdown during cooking. Conversely, SAMPEA 20T exhibited an increase in crude fiber content after boiling (4.85%) and roasting (6.00%), a result echoed by Aremu *et al.* (2006), who also found increased fiber content in processed cowpeas. The increase in fiber after roasting in SAMPEA 20T (Table 2) may be due to heat-enhanced extractability, making the fibers more available. Ene-Obong and Carnovale (1992) also reported that processing can affect fiber composition in legumes, with roasting potentially enhancing fiber content.

SAMPEA-11 (Table 1) experienced a reduction in crude lipid content after both boiling and roasting, a trend observed by Ndidi *et al.* (2018) in cowpea seeds where lipid loss was attributed to leaching or breakdown during processing. In contrast, SAMPEA 20T exhibited an increase in lipid content after boiling (6.31%) and roasting (7.72%). Olapade *et* *al.* (2012) noted a similar increase in lipids after roasting, suggesting that the removal of moisture concentrates fats in roasted seeds. This suggests that SAMPEA 20T (Table 2) may offer higher lipid content, making roasted seeds a better source of healthy fats.

Boiling and roasting significantly reduced the protein content of SAMPEA-11 (Table 1), from 17.50% in the unprocessed sample to 7.44% (boiled) and 9.63% (roasted). This is consistent with Ndidi *et al.* (2018) and Olapade *et al.* (2012), who also observed protein loss after boiling due to denaturation or leaching. In contrast, SAMPEA 20T (Table 2) showed an increase in protein content after boiling (16.18%) and roasting (12.92%), which may be due to protein concentration effects as water is lost, as noted by Aremu *et al.* (2006). This makes SAMPEA 20T a better option for those seeking higher protein content after processing.

In SAMPEA-11 (Table 3), boiling was effective in reducing tannins, oxalates, and phytates, with roasting having a lesser effect. This aligns with Ndidi *et al.* (2018), who also reported that boiling reduces antinutritional factors in cowpeas due to their leaching into the water. Aletor and Aladetimi (1989) similarly noted that boiling legumes significantly reduces antinutritional compounds, improving the nutritional quality of the seeds. SAMPEA 20T (Table 4), however, exhibited an increase in tannin levels after boiling (21.35%) and roasting, a trend contrary to Aremu *et al.* (2006), who generally observed a reduction in tannin levels after boiling. These discrepancies may arise from varietal differences or the extent of heat treatment during processing. Generally, boiling appears more effective than roasting for reducing antinutritional factors in SAMPEA-11, while SAMPEA 20T shows a mixed response.

SAMPEA-11 (Table 5) had a high folate content in the unprocessed sample (83.51 mg), but this was drastically reduced by boiling (35.80 mg) and eliminated entirely by roasting. These findings are consistent with Ndidi *et al.* (2018), who observed that boiling depletes water-soluble vitamins like folate in cowpeas. Aletor and Aladetimi (1989) similarly reported folate losses during the cooking process. In contrast, SAMPEA 20T retained more folate after boiling (17.47 mg), a slight increase from the unprocessed sample, though roasting significantly reduced the content. Ene-Obong and Carnovale (1992) also found that boiling legumes can help preserve more folate than other methods, making it a better option for preserving this important vitamin.

Findings from SAMPEA-11 and SAMPEA 20T reflect trends observed in previous studies, such as those by Ndidi *et al.* (2018), Olapade *et al.* (2012), and Aremu *et al.* (2006). The results show that roasting generally concentrates nutrients like carbohydrates and lipids but leads to significant losses in moisture and some vitamins, while boiling is more effective at reducing antinutritional factors and retaining water-soluble vitamins like folate. Both varieties exhibit distinct nutritional advantages depending on the processing method, making them valuable for different dietary applications.

CONCLUSION

The results of this study demonstrate that both boiling and roasting significantly impact the proximate composition and antinutritional content of SAMPEA-11 and SAMPEA 20T cowpea varieties, while each processing method offering distinct nutritional benefits, roasting was shown to concentrate carbohydrates, lipids, and minerals, enhancing the energy density and mineral retention of the seeds, particularly in SAMPEA-11. The carbohydrate content in SAMPEA-11 increased by 19.28% after roasting, while moisture content drastically reduced by 83.98%. Similarly, boiling increased moisture by 106.46%, while reducing crude fiber by 43.23% and protein by 57.49%. In SAMPEA 20T, roasting led to a 6.87% increase in carbohydrates and a 16.89% increase in lipid content, while boiling caused a 68.47% reduction in moisture and a 14.54% increase in crude protein. SAMPEA-11 exhibited greater reductions in moisture and crude fiber content after processing, while SAMPEA 20T demonstrated notable increases in protein and lipid content post-processing. These findings suggest that roasting and boiling can be employed to optimize the nutritional profiles of cowpeas, depending on desired dietary outcomes, while maintaining a focus on the distinct changes in nutrient composition after processing.

This research provides valuable insights into how processing methods impact the nutritional and anti-nutritional profiles of cowpea varieties, guiding food processing decisions to optimize the nutritional benefits of cowpea-based products.

REFERENCES

AOAC, (2012). Association of Official Analytical Chemists, Official Method of Analysis, AOAC, Washington (DC), 19th edition.

Biotech Updates. (2010, April 23). *Improved cowpea varieties in Nigeria's savanna region*. Retrieved from. (https://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=5922 .

Fernández-Aulis, F., Rodríguez-Roque, M. J., Rojas, M. L., & Morales-Castro, J. (2021). "Effect of traditional cooking methods on phenolic compounds and antioxidant activity of colored corn." *Journal of Food Science and Technology, 58*, 2893-2903.

Gao, Y., Shang, C., Maroof, M. S., Biyashev, R. M., Grabau, E. A., Kwanyuen, P., ... & Buss, G. R. (2007). A modified colorimetric method for phytic acid analysis in soybean. *Crop science*, *47*(5), 1797-1803.

https://www.iita.org/news-item/improved-cowpea-varieties-hit-nigerias-savanna-region/

IAR, Zaria & IITA, Kano Station. Released and registered in 2009. Breeders: M. F. Ishiyaku, B.B. Singh, A.A. Zaria, O.O. Olufajo, R.A. Adeleke, H. Ajeigbe, & Y. Kamara.

IAR, Zaria, & IITA, Ibadan. (2009). *SAMPEA 11 (IT89KD-288)* [Cowpea variety].

Ihediohanma, N. C., Ofoedu, C. E., Ojimba, N. C., Okafor, D. C., & Adedokun, A. O. (2014). Comparative effect of milling methods on the proximate composition and functional properties of cowpea (Vigna unguiculata). *International Journal of Life Sciences*, *3*(4), 170-177.

Inuwa, H. M., Aina, V. O., Gabi, B., Aimola, I. and Toyin, A. (2011). Comparative determination of antinutritional factors in groundnut oil and palm oil. *Advance Journal of Food Science and Technology*, *3*(4), 275-279.

Makinde, F. M., & Abolarin, O. O. (2020). Effect of post-dehulling treatments on anti-nutritional and functional properties of cowpea (Vigna unguiculata) flour. *Journal of Applied Sciences and Environmental Management*, *24*(9), 1641-1647.

Malik, D., Narayanasamy, N., Pratyusha, V. A., Thakur, J., & Sinha, N. (2023). Inorganic Nutrients: Macrominerals. In *Textbook of Nutritional Biochemistry* (pp. 391-446). Singapore: Springer Nature Singapore.

Naik, V. V., Patil, N. S., Aparadh, V. T. and Karadge, B. A. (2014). Methodology in determination of oxalic acid in plant tissue: a comparative approach. *Journal of Global Trends in Pharmaceutical Sciences*, *5*(2), 1662-1672.

Ndidi, U. S., Ndidi, C. U., Aimola, I. A., Bassa, O. Y., Mankilik, M. and Adamu, Z. (2014). Effects of processing (boiling and roasting) on the nutritional and antinutritional properties of Bambara groundnuts (Vigna subterranea [L.] Verdc.) from Southern Kaduna, Nigeria. *Journal of food processing*, *2014*.

Nwachukwu, W. (2015). *Profitability and efficiency of SAMPEA-11 variety of cowpea production in Niger State, Nigeria* (Master's thesis, Ahmadu Bello University, Zaria). Retrieved from https://kubanni.abu.edu.ng/items/5e6a6c2a-b3c1-4b4e-83e8-65bd648d43e1

Oly-Alawuba, N. & Uzochukwu, I. (2020). Effect of Processing (Boiling, Frying, And Roasting) on the Nutrient, Antinutient and Phytochemical Composition of Two

Varieties of Cocoyam, (Colocasia esculenta). *Current Developments in Nutrition*. 4. 768-768. 10.1093/cdn/nzaa052_037.

Omenna, E. C., Olanipekun, O. T., & Kolade, R. O. (2016). Effect of boiling, pressure cooking and germination on the nutritional and antinutrients content of cowpea (Vigna unguiculata). *ISABB Journal of Food and Agricultural Sciences*, *6*(1), 1-8.

Onwugbuta-Enyi, J. (2004). Water balance and proximate composition in cowpea (Vigna unguiculata (L). Walps) seedlings exposed to drought and flooding stress.

Onwuka, G. I. (2005). *Food analysis and instrumentation: theory and practice*. Napthali prints.

Owolabi, A. O., Ndidi, U. S., James, B. D., & Amune, F. A. (2012). Proximate, antinutrient and mineral composition of five varieties (improved and local) of cowpea, Vigna unguiculata, commonly consumed in Samaru community, Zaria-Nigeria. *Asian Journal of Food Science and Technology*, *4*(2), 70-72.

Polshettiwar, S. A., Ganjiwale, R. O., Wadher, S. J., & Yeole, P. G. (2007). Spectrophotometric estimation of total tannins in some ayurvedic eye drops. *Indian Journal of Pharmaceutical Sciences*, *69*(4).

Torres, J., Peters, M., & Montoya, C. A. (2019). Boiling influences the nutritional value of three seed cowpea (Vigna unguiculata) varieties using in vivo and in vitro methods. *Food chemistry*, *297*, 124940.

USDA. (2021). Food Data Central. https://fdc.nal.usda.gov/ (accessed January 11, 2024).

Vasconcelos, I. M., & Oliveira, J. T. A. (2020). "Antinutritional properties of plant lectins and their detection methods: An overview on recent advances." *Toxicon, 183*, 64-76.

Zhang, B., & Deng, Z. (2019). Changes in chemical composition, physical properties and microstructure of vegetables subjected to different cooking methods. *Food Chemistry*, 283, 49-57. DOI: 10.1016/j.foodchem.2018.12.126.