Physicochemical Characteristics of Hydrocolloids Extracted from Peels and Flesh Flour of Selected Root and Tuber Crops in South-Eastern Nigeria

Alice N. Ohuoba

National Root Crops Research Institute, Umudike, Nigeria

ARTICLE HISTORY
Received Date: 15th June, 2025
Accepted Date: 31st July, 2025

http: www.njphr.nspri.gov.ng
ISSN: 2630-7022

CORRESPONDING AUTHOR
Alice N. Ohuoba
Yam Programme, National Root Crops Research Institute, Umudike, Nigeria.
aliceohuoba@gmail.com
+234 -703-255-6193

CONFLICT OF INTEREST: None
ETHICAL APPROVAL: Not Applicable

This is a publication of the Nigerian Stored Products Research Institute (NSPRI)

OPEN ACCESS

Abstract

Plant-based hydrocolloids are widely used in food, cosmetic, and pharmaceutical industries for their natural thickening and stabilizing properties. With rising demand for clean-label and functional ingredients, root and tuber hydrocolloids offer a sustainable solution. Hence, the study analysed the physicochemical properties of hydrocolloids extracted from the peels and flesh flour of specific root and tuber crops grown in south-eastern Nigeria. Hydrocolloids were extracted from flour of Trifoliate yam (Dioscorea dumentorum), aerial yam (Dioscorea bulbifera), water yam (Dioscorea alata), white yam (Dioscorea rotundata), cocoyam (Colocasia esculenta), white and yellow fleshed sweet potato (Ipomoea batatas). The hydrocolloids were tested to determine the proximate composition, functional properties, gelation temperature, and pH levels. The findings revealed significant differences ($P < 0.05$). Moisture contents of flesh and peel samples ranged from 3.635% to 9.791%. Ash content from 0.60% to 6.10%. Crude fibre from 0.363 to 5.425 %, Carbohydrate from 82.294 % to 94. 406%. Functional properties results recorded highest values of 1.441(water yam peel) in swelling index, 4.200 % (water yam flesh) in foaming capacity, 78.805 % (yellow fleshed sweet potato flesh) in solubility, 2.205 (white yam peel) in oil absorption capacity, 2.505 (trifoliate yam flesh) in water absorption capacity, 69.310 % (cocoyam flesh) in emulsifying capacity, 75.615; 0.561; 0.766 (white fleshed sweet potato flesh) in freeze thawing stability, bulk density and tapped density. The highest values of gelation temperature and pH were observed in cocoyam peel (83 °C) and aerial yam peels (7.6). The potential of these hydrocolloids lies in their use as natural and sustainable ingredients in food formulations.

Keywords:
Flesh, Flour, Hydrocolloids, Peels, Root and tuber crops

Introduction

Hydrocolloids, water-soluble polysaccharides derived from plant, microbial, or marine sources, are commonly employed in food systems to modify texture, stability, and moisture retention (Haegens, 2014; Chaplin, 2014; Ohuoba et al., 2019). They contribute to the majority of food consumed, having their known shape or consistency (IFAC, 2014).

Hydrocolloids are widely used in processed food products, as they provide the stability, texture, and appearance required (Nathan, 2011). Plant-derived hydrocolloids absorb water and form gels, which is crucial for their industrial application (Emmanuel et al., 2014). The moisture content of hydrocolloids affects their shelf life in storage; therefore, it is imperative to maintain a moisture level as low as possible, ideally below 13% (Ohuoba et al., 2019). Hydrocolloids are widely utilized in the food, pharmaceutical, and cosmetic industries, and their significance lies in both their functional and nutritional properties. The functional importance of hydrocolloids lies in their roles in modifying food texture, stabilizing emulsions, and controlling moisture. These properties are especially critical in food formulation and shelf-life extension (Ahmad et al., 2024).

How to cite:

Ohuoba, A. N. (2025). Physicochemical Characteristics of Hydrocolloids Extracted from Peels and Flesh Flour of Selected Root and Tuber Crops in South-Eastern Nigeria. *Nigerian Journal of Post-Harvest Research*, 3(5), 71-78.

Hydrocolloids such as xanthan gum, guar gum, and carrageenan are widely used as thickening agents. Their ability to interact with water and form structured networks makes them essential in products like sauces, dairy, and desserts (Imeson, 2010). This property is crucial in soups, sauces, desserts, and dairy products (Saha & Bhattacharya, 2010). The stabilisation properties of hydrocolloids, such as their ability to increase the viscosity of the continuous phase and reduce droplet movement and coalescence, help maintain the stability of emulsions (Dickinson, 2003). This is particularly critical in products such as salad dressings, ice cream, whipped toppings, and beverages. Hydrocolloids can mimic the mouthfeel of fats and sugars without contributing significant calories, making them ideal for low-calorie, reduced-fat, and diabetic-friendly products (Imeson, 2010). Moisture-retention and fat-replacement hydrocolloids, such as methylcellulose and alginate, trap water within the food matrix, helping to reduce moisture loss and mimic the mouthfeel of fats, making them valuable in reduced-fat and gluten-free formulations (Saha & Bhattacharya, 2010). In Texture modification, hydrocolloids modify texture by affecting viscosity and gel strength, as well as influencing the sensory qualities of foods, such as creaminess, thickness, or chewiness. For example, carrageenan can create a firm, elastic gel in dairy desserts. For instance, pectin can provide a soft or firm gel depending on pH and sugar content, making it ideal for jams and jellies (Thakur et al*,* 1997).

Hydrocolloids have a high water-holding capacity (WHC), which enables them to bind water within food systems, thereby reducing syneresis and extending shelf life. This is especially important in the bakery, meat, and frozen food industries (Phillips & Williams, 2009).

The proximate composition refers to the chemical composition of food. The proximate composition of hydrocolloids contributes to the nutritional and compositional attributes of foods. Although not significant macronutrients, hydrocolloids can significantly influence the proximate composition of food formulations. Nutritional profile of food, including moisture, fiber, protein, and energy content. Hydrocolloids can serve as a dietary fibre source. Some hydrocolloids, like psyllium, inulin, and some gums, are recognised as soluble fibers. They are resistant to digestion in the small intestine and contribute to bowel health, gut health, glycemic control, and satiety (Mudgil & Barak, 2013). Hydrocolloids have water-holding capacity. Thus, by holding water, hydrocolloids can reduce the caloric density of foods and improve satiety. This property is important in weight management and the formulation of health foods (Phillips & Williams, 2009). In terms of caloric contribution, most hydrocolloids contribute minimal calories; however, their impact on digestion and energy availability can vary. Some may be fermented in the colon, contributing to the production of short-chain fatty acids, which have systemic health benefits (Elleuch et al., 2011). Hydrocolloids typically contain negligible protein and fat. However, their carbohydrate content, mainly in the form of non-starch polysaccharides, plays a role in determining the fiber and total carbohydrate content in proximate analyses (Phillips & Williams, 2009). Depending on their source, hydrocolloids may contain varying levels of moisture and ash (mineral) content. These components affect their classification and labeling in food composition tables (Thakur et al., 1997).

Root and tuber crops are staple foods worldwide, accounting for nearly 45% of global tuber consumption (FAO, 2014). Nigeria is a leading producer of yams and cocoyams globally, and the largest producer of sweet potatoes in sub-Saharan Africa (Amadi et al., 2011). Despite the high production of these crops, postharvest losses of 30-50% are common, mostly due to their high moisture content and the inefficiency in processing (Taiwo, 2014). The high moisture content makes these crops susceptible to spoilage, which is a crucial setback in storing them, as they become unavailable during the off-season. Processing them into value-added products can increase their shelf life. However, processing the flesh and peels of these tuber crops into hydrocolloids and using them in food formulation is a way to prevent postharvest waste of these crops (Ohuoba & Onwuka, 2016). Previous studies have isolated hydrocolloids from the peels of three yam species (Ohuoba et al., 2019).

Materials and Methods

Raw materials used were trifoliate yam (*Dioscorea dumentorum*), aerial yam (*Dioscorea bulbifera*), water yam (*Discorea alata*), white yam (*Discorea rotundata*), cocoyam (*Colocasia esculenta*), white and yellow fleshed sweet potato (*Ipomoea batatas*). These were obtained from the National Root Crops Research Institute experimental farm in Umudike, Abia State, Nigeria. Flour of sweet potatoes, yams, and cocoyams was prepared using the procedure described by Ohuoba et al. (2019) as shown in the flow chart (Figure 1).

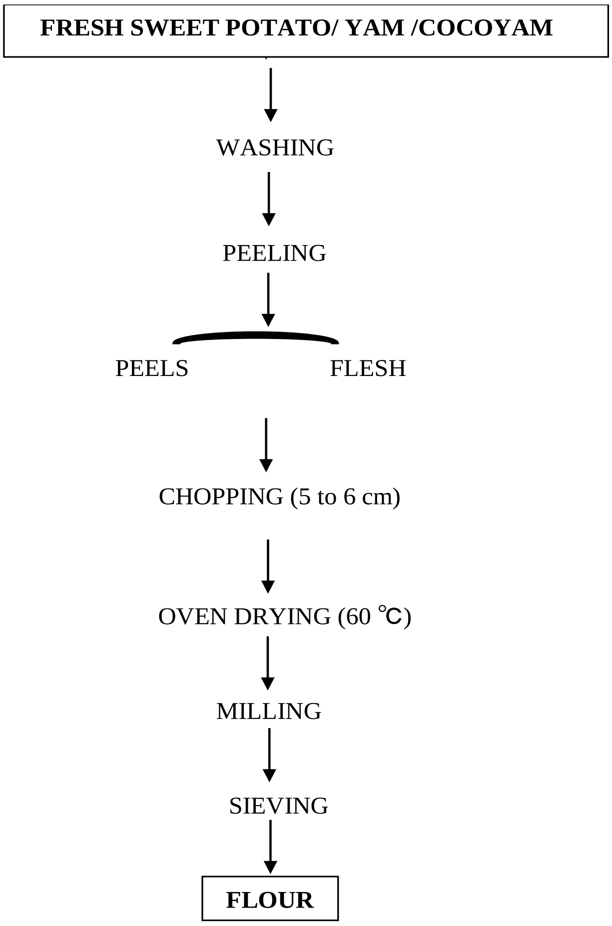

Figure 1: Flow chart for the production of flour from flesh and peels of sweet potato, yam, and cocoyam.

The peels and fresh flour samples were defatted as described by Size-Tao & Sathe (2004). The flour samples were soaked with n-hexane at a ratio of 1:10 (w/v) for 24 hours. A mixture of fat and solvent (n-hexane) was filtered using filter paper. The residue left in the filtered paper is the defatted flour sample.

Hydrocolloids were extracted and purified using techniques described by Ohuoba et al. (2019). In a 1000 mL beaker, 120 g of fresh, defatted sample peels were mixed with 800 mL of distilled water, and the resulting supernatant was then decanted. A muslin cloth was used to filter the material remaining in the beaker. A muslin cloth was used to filter each residue once more after it had been reconstituted with 500 mL of distilled water. The residue was supplemented with excess cold 99.9% ethanol. When the material in the beaker was filtered through a muslin cloth, the resulting precipitate was collected as a residue. Using a tablespoon, the crude hydrocolloids were transferred into a 500 ml beaker. After being dissolved in distilled water, the crude extract was homogenised and progressively precipitated with twenty (20) percent Ammonium sulfate and then washed with distilled water. Excess cold 99.9% ethanol was used to precipitate the residue after washing in 500mL. The process was repeated several times and stopped when the washing was negative to the biuret test. Precipitated hydrocolloid extracts were dewatered and oven-dried at 65 □ for 48 hours.

Proximate composition analysis (moisture, crude fiber, ash, crude protein, and fat) was determined as described by the Association of Official Analytical Chemistry (AOAC, 2023) standards.

Functional properties were: swelling index by the method of Iwuoha (2004), bulk density by the method of Nep & Conwey (2011), solubility by the method of Nwanekezi et al. (2001), and freeze-thaw stability by the method of Igwe & Nwokocha (2014). Emulsifying capacity, gelation temperature, and pH were measured using the methods of Onwuka (2005).

Data analysis

The data obtained was in duplicate. Analysis of Variance (ANOVA) was used to determine the level of significance, and the means were separated using the Duncan Multiple Range Test in the Statistical Analysis System (SAS) software.

Results and Discussions

Table 1 shows the proximate analysis of the flesh and peel samples of the hydrocolloids. Significant differences (P<0.05) were seen in all parameters. The moisture contents ranged from 3.635% to 9.791%, with trifoliate yam peel (9.635%) having the highest value and cocoyam flesh (3.635%) having the lowest value. This aligns with recommended safe moisture levels below 13% (Nebraska Wheat Board, 2009), which helps prevent microbial growth (Scott, 1991). These differences may impact shelf life and storage stability, as higher moisture contents are associated with increased perishability (Adebowale et al., 2005). Ash content, which reflects the total mineral content, was highest in aerial yam peel (6.100%) and lowest in white flesh potato peel (0.600%), indicating a richer mineral composition in the aerial yam peel hydrocolloid. This aligns with previous studies that highlighted peels as valuable sources of minerals often discarded during processing (Osundahunsi et al., 2003). Ash contents were higher than reported values for locust bean gum and cashew gum (Raquel et al., 2002; Kwabena et al., 2010). The crude fibre content ranged from 0.363 to 5.425% consistent with cashew gum findings (Kwabena et al., 2010). Crude fibre was observed to be higher in white flesh potato flesh

(4.366%), trifoliate yam flesh (5.425%), and trifoliate yam peel (4.130%), whereas the lowest values were in cocoyam flesh (0.449%) and white yam peel (0.432%). 4.130%. Carbohydrate content was highest in cocoyam flesh (94.406%) and cocoyam peel (93.655%), while the lowest was found in trifoliate yam peel (82.294%). The absence of fat and protein content indicates effective defatting and purification.

The results of the proximate composition of purified hydrocolloids extracted from the flesh and peel of various roots and tubers revealed notable differences in moisture, ash, crude fibre, and carbohydrate contents, suggesting variation in nutritional content depending on the crop source. The relatively low moisture content observed in cocoyam and water yam hydrocolloids suggests greater stability and potential for industrial applications where low moisture is desirable. The findings obtained from ash content results support the potential use of yam peels, particularly from aerial and trifoliate yams, as functional food ingredients rich in micronutrients. High fibre content contributes to dietary health and is also beneficial in food formulations due to its water-binding and textural properties (Adejumo et al., 2013). The results of crude fibre indicate the superiority of trifoliate yam (5.425% flesh, 4.130% peel) hydrocolloids in providing dietary fiber among the tubers studied. The high carbohydrate levels in cocoyam-based hydrocolloids suggest they may be particularly useful as energy-dense ingredients or thickeners in food formulations, consistent with earlier findings on the carbohydrate-rich nature of cocoyam (Onyenekwe et al., 2010).

Table 1: Proximate properties of flesh and peel purified hydrocolloids samples

Samples name	Moisture (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)
Trifoliate yam Flesh	5.006^{k}	5.900^{b}	5.425^{a}	84.161^{m}
Peel	9.791^{a}	5.425^{cs}	4.130^{c}	82.294^{n}
Aerial yam Flesh	8.197^{d}	1.745^{e}	0.363^{n}	89.936^{h}
Peel	7.896^{e}	6.100^{a}	1.550^{h}	87.053^{l}
White yam Flesh	9.165^{b}	1.345^{j}	2.333^{f}	87.498^{k}
Peel	8.339^{c}	1.725^{f}	0.432^{m}	89.694^{j}
Water yam Flesh	3.865^{m}	1.200^{k}	3.280^{d}	92.405^{d}
Peel	5.305^{j}	3.555^{d}	0.463^{k}	93.031^{c}
Cocoyam Flesh	3.635^{n}	1.510^{g}	0.449^{l}	94.406^{a}
Peel	4.402^{l}	1.090^{l}	0.853^{j}	93.655^{b}
White flesh potatoes Flesh	5.977^{f}	1.230^{j}	4.366^{b}	89.430^{j}
Peel	5.683^{g}	0.600^{n}	2.513^{e}	91.417^{f}
Yellow flesh potatoes Flesh	5.481^{i}	1.350^{h}	1.310^{j}	91.859^{e}
Peel	5.664^{h}	0.940^{m}	2.312^{g}	91.124^{g}
LSD	0.0051	0.0031	0.0026	0.0032

Means with the same letter in the same column are not significantly different ($P < 0.05$).

Table 2 shows the functional composition of the flesh and peel samples. There were significant differences ($P < 0.05$) in the results recorded. The swelling index of the flesh and peel samples ranged from 1.057 to 1.441. Water yam peel sample (1.441) was higher than that of trifoliate yam flesh (1.375). The peel sample of trifoliate yam (1.057) was the lowest and had a significant difference with the white yam flesh sample (1.082). The swelling index is the calculation of the ability of hydrocolloids (food gums) granules to hydrate (Nemtanu & Brasaveanu, 2014). It is a property that facilitates interaction among food gum chains (Hoover, 2001; Ratneyake et al., 2002). Reports from many investigators indicated that the content of components, substances, especially fat, protein, and starch, influences the swelling index (Woolfe, 1992; Ikegwu et al., 2010).

The foaming capacities of the flesh and peel samples ranged from 0.201 to 4.200. Water yam flesh (4.200%) was the highest, having significant differences ($P<0.05$) with trifoliate yam flesh (4.000%) and trifoliate yam peel (4.000%). Aerial yam peel (0.201) had the lowest and had no significant difference with white flesh sweet potato peel (0.230). The low foaming capacities may result from the lack of protein in the hydrocolloid samples. As reported by Kerr et al. (2000) and Kinsella (1979), a decrease in protein content leads to a decrease in foaming capacity.

The percentage (%) solubility of the samples ranged from 51.565% to 78.805% with white yam peel (51.565%) having the lowest and yellow flesh sweet potato flesh (78.805%) having the highest. There were noticeable differences ($P < 0.05$) between the samples. The results indicate that the purified hydrocolloids from the flesh of the tuber crops were more soluble than the peels.

The oil absorption capacity of the flesh and peel samples ranged from 0.810 to 2.205, with the white yam peel (2.205) having the highest value and the lowest in cocoyam flesh (0.810). The peel sample, white yam peel (2.205), was higher than the flesh sample, trifoliate yam flesh (2.000). However, there were no significant differences between water yam peel (1.410) and White flesh sweet potato peel (1.305). In water absorption capacity, the range was from 1.050 to 2.505, with trifoliate yam flesh having the highest and the lowest in cocoyam flesh (1.050). The values suggest good functionality in reducing syneresis and modifying food textures (Atuonwu et al., 2010). The emulsifying capacities of the flesh and peel samples ranged from 37.660% to 69.310% with cocoyam flesh (69.310%) having the highest, and the lowest was recorded in the water yam peel sample (37.660%). However, there were noticeable differences (P<0.05) between cocoyam flesh and trifoliate yam flesh (57.875%). These results showed that the cocoyam flesh samples (68.945%) had an emulsifying capacity that was higher than the sample cocoyam peel (54.345%)

The freeze-thaw stability results ranged from 53.805% to 75.615%. There were significant differences (P < 0.05) in the freeze-thaw stability of the flesh and peel samples, respectively, with White flesh sweet potato flesh (75.615%) having the highest and cocoyam flesh (53.805%) having the lowest. Although the highest freeze-thaw stability was observed in the flesh sample, the peel samples seem to be more stable in the frozen state.

Table 2: Functional properties of flesh and peel purified hydrocolloids samples

Sample name	S.I	FC (%)	SOL (%)	OAC	WAC	EC (%)	FTS (%)	D_B g/ml	D_T g/ml
Trifoliateyam Flesh	1.375^{b}	4.000^{b}	67.555^{g}	2.000^{c}	2.505^{a}	57.875^{b}	69.140^{k}	0.281^{k}	0.381^{l}
Peel	1.057^{n}	4.000^{b}	67.455^{l}	2.050^{b}	2.050^{b}	48.885^{e}	73.090^{e}	0.455^{fe}	0.601^{i}
Aerial yam Flesh	1.245^{d}	3.000^{c}	63.555^{l}	1.805^{e}	1.505^{ced}	39.560^{m}	70.355^{g}	0.481^{d}	0.671^{e}
Peel	1.235^{e}	0.201^{k}	67.520^{h}	1.905^{d}	2.050^{b}	47.825^{g}	74.260^{c}	0.452^{f}	0.632^{f}
Whiteyam Flesh	1.082^{m}	2.000^{f}	57.905^{m}	1.705^{f}	1.510^{ced}	44.045^{j}	54.370^{m}	0.304^{j}	0.527^{j}
Peel	1.309^{c}	1.900^{g}	51.565^{n}	2.205^{a}	1.550^{ced}	45.340^{l}	69.635^{h}	0.331^{h}	0.526^{j}
Wateryam Flesh	1.130^{j}	4.200^{a}	65.405^{k}	1.150^{k}	1.205^{fe}	43.945^{k}	69.365^{l}	0.501^{b}	0.716^{c}
Peel	1.441^{a}	2.105^{e}	70.640^{e}	1.410^{j}	1.305^{fed}	37.660^{n}	68.550^{l}	0.456^{e}	0.626^{g}
Cocoyam Flesh	1.105^{k}	2.350^{d}	78.081^{b}	0.810^{m}	1.050^{f}	69.310^{a}	53.805^{n}	0.483^{d}	0.742^{b}
Peel	1.095^{l}	2.000^{f}	70.905^{d}	1.055^{j}	1.305^{fed}	54.345^{j}	69.305^{j}	0.481^{d}	0.741^{b}
White flesh potatoes									
Flesh	1.140^{h}	1.055^{i}	71.150^{c}	1.305^{j}	1.905^{cb}	54.905^{c}	75.615^{a}	0.561^{a}	0.766^{a}
Peel	1.211^{f}	0.230^{j}	67.241^{j}	1.305^{j}	1.400^{fed}	45.905^{h}	74.325^{b}	0.491^{c}	0.705^{d}
Yellow flesh potatoes									
Flesh	1.150^{g}	2.100^{e}	78.805^{a}	1.605^{g}	1.705^{cbd}	47.830^{f}	71.405^{f}	0.406^{g}	0.613^{h}
Peel	1.110^{j}	1.230^{h}	68.935^{f}	1.455^{h}	1.600^{ced}	40.525^{l}	73.235^{d}	0.309^{l}	0.508^{k}
LSD	0.0033	0.0811	0.0024	0.0029	0.4061	0.0028	0.0029	0.0031	0.0029

Samples with the same superscript in the columns are not significantly different (P > 0.05). KEYS: S.I= swelling index, FC= Foaming capacity, SOL= Solubility, OAC= Oil absorption capacity, WAC= Water absorption capacity, EC= Emulsifying capacity, FTS= Freeze thawing stability, DB= Bulk density, DT= Tapped density

The Bulk density (D_B) ranged from 0.281 g/ mL to 0.561 g/mL, with white flesh sweet potato flesh (0.561 g/ mL) having the highest, and the lowest being trifoliate yam flesh (0.281 g/ mL). The highest bulk density in the flesh sample, white flesh sweet potato flesh (0.561 g/mL), was higher than that in the peels of the white flesh sweet potato sample (0.491 g/mL) and was significantly different. The results recorded could be attributed to the tuber flours, which were defatted before the extraction of the food gums, thereby helping to improve bulk density (Adebowade et al., 2005). Lower bulk density signifies higher porosity (Ikoni et al., 2012; Krokida & Maroulis, 1997). Thus, trifoliate yam flesh samples (0.281; 0.283) with lower bulk density will have a higher porosity compared to other flesh and peel samples. Tapped density (D_T) of both flesh and peel samples ranged from 0.381 g mL to 0.766 g/ mL, with white flesh sweet potato flesh (0.766 g/mL) having the highest, and the trifoliate yam flesh (0.381 g/ mL) samples the lowest. The bulk density and tapped density of a material can affect the handling and process method to be adopted when it is included in a formulation. Ikoni et al. (2012) reported that a material with high tapped density would be a highly compressible material.

Table 3 shows the gelation temperature and pH measurement of the hydrocolloid samples obtained from the flour of flesh and peels of the experimental materials. The gelation temperature of flesh samples ranged from 69 to 81 °C, with a pH of 6.9 to 7.1, while the peel samples had a gelation temperature of 70 to 83 °C, with a pH of 7.2 to 7.6, which falls within the range of gellan gum gelation temperatures (Achi & Okolo, 2004).

Comparing the results shown in Table 3, the gelation temperature (83 °C) and pH (7.6) of the hydrocolloids from tuber peel flour were the highest. However, there seems to be a similarity in the results of individual samples from the same flesh or peels of tuber species. This result showed that the extracted hydrocolloids exhibit gelling behavior similar to polysaccharides like carrageenan, pectin, agar, and alginate (RSS Feed, 2014), and could be applied in the formulation of food at certain temperatures in food processing (Konjac, 2014).

Table 3: Gelation temperature (GT) and pH of the flesh and peel hydrocolloids samples

Sample name	GT (□)	pH
Trifoliate yam flesh	70.0^{l}	6.9^{bcd}
Peel	70.0^{l}	7. I^{bc}
Aerial yam flesh	73.5^{i}	7.2^{b}
Peel	80.0^{e}	7.6^{a}
White yam flesh	78.0^{f}	7.1^{bc}
Peel	81.5^{c}	7.2^{b}
Water yam flesh	81.0^{d}	7.1^{bc}
Peel	75.5^{i}	6.8^{cd}
Cocoyam flesh	77.5^{g}	7.0^{bcd}
Peel	83.0^{a}	6.7^{d}
White flesh sweet potato flesh	72.5^{k}	7.1^{bc}
Peel	82.0^{b}	6.9^{bcd}
White flesh sweet potato flesh	77.0^{h}	7.0^{bcd}
Peel	75.5^{i}	6.8^{cd}
LSD	0.3033	0.3033

Samples with the same superscript down the columns are not significantly different ($P > 0.05$)

Conclusion

The study demonstrated that hydrocolloids extracted from the peels and flesh of yams, cocoyam, and sweet potato exhibit considerable variation in both proximate and functional properties. Notably, the proximate composition of hydrocolloids from tuber peels was often comparable to or even surpassed that of the flesh, indicating that peels are a nutritionally valuable resource. This finding supports the potential for reducing agricultural waste through the effective utilisation of peels in food and industrial applications.

Functionally, the hydrocolloids showed favourable swelling, emulsifying, and absorption capacities, making them suitable for a wide range of food applications. In particular, cocoyam and sweet potato varieties exhibited strong potential for use in industrial food design and formulation.

Overall, the multi-functionality of hydrocolloids, particularly their ability to modify texture, retain moisture, stabilise emulsions, and enhance dietary fibre content, reinforces their critical role in modern food systems. Their versatility continues to support innovation in the development of health-oriented and plant-based food products.

Funding Statement

This research was funded by myself.

References

Adebowade, Y. A., Adeyemi, I. A., & Oshodi, A. A. (2005). *Functional and physicochemical properties of flours of six Mucuna species*. *African Journal of Biotechnology*, *4*, 1461–1468.

Adebowale, K. O., Adewale, I. O., & Adebowale, Y. A. (2005). Functional properties of native, physically and chemically modified breadfruit (*Artocarpus altilis*) starch. *Industrial Crops and Products*, *21*(3), 343–351. https://doi.org/10.1016/j.indcrop.2004.06.003

Adejumo, B. A., Ifedigbo, P. C., & Alade, O. P. (2013). Proximate composition and mineral content of yam peels and flour. *International Journal of*

Scientific and Research Publications, *3*(12), 1–4.

Ahmad, M., Khan, M. K. I., Saeed, F., Imran, M., & Nadeem, M. (2024). Applications of hydrocolloids in the food industry: An overview. *Food Hydrocolloids, 142*, 109833. https://doi.org/10.1016/j.foodhyd.2024.109833

Amadi, C. O., Ekwe, K. C., Chukwu, G. O., Oloyede, A. O., & Egesi, C. N. (2011). *Root and tuber crops*. Snap Press Ltd.

Association of Analytical Chemists (AOAC). (2023). *Official methods of analysis of the AOAC* (22nd ed.). Washington, DC.

Atuonwu, A.C., Onwuka, G.I. &Ibeawuchi, G.I. (2010). Comparative study on the role of food gums in the production of cocoa-enriched candies. *Nigeria Food Journal* 28 (1).

Chaplin, M. (2014). Hydrocolloids and gums: Creative Common attributes (version 2.0). *LSBU*. http://www.lsbu.ac.uk/water/hydro.html

Dickinson, E. (2003). Hydrocolloids at interfaces and the influence on the properties of dispersed systems. *Food Hydrocolloids, 17*(1), 25–39. https://doi.org/10.1016/S0268-005X(01)00120-5

Elleuch, M., Bedigian, D., Roiseux, O., Besbes, S., Blecker, C., & Attia, H. (2011). Dietary fibre and fibre-rich by-products of food processing: Characterisation, technological functionality and commercial applications: A review. *Food Chemistry, 124*(2), 411–421. https://doi.org/10.1016/j.foodchem.2010.06.077

Emmanuel, P. A., Boudjeko, T., Woguia, A. L., Nintang-Yanou, N., Gaiani, C., Scher, J., & Mbofung, C. M. F. (2014). [Title unavailable]. *Journal of Polymers*. Article ID 926850, 10 pages. http://dx.doi.org/10.1155/2014/926850

FAO (Food and Agricultural Organization). (2014). *Appendix 4 – Global production and consumption of roots and tubers*. http://www.fao.org/./xs791/eOg.htm

Haegens, N. (2014). Bakery technology – hydrocolloids. *Classofoods*. http://www.classofoods.com/page/_9html

Hoover, R. (2001). Composition, molecular structure and physicochemical properties of tuber and root starches: A review. *Carbohydrate Polymers, 45*(3), 253–267.

IFAC. (2014). *The benefits of food additives: Making food better*. Retrieved July 21, 2024, from IFAC website.

Igwe, O. U., & Nwokocha, L. M. (2014). Isolation of gum from the seeds of *Delonix regia* and evaluation of its interactions with cassava and maize starches. *International Journal of Chemical and Biochemical Sciences*. http://www.scientific.org/journal/_html

Ikegwu, O. J., Okechukwu, P. E., & Ekumankana, E. O. (2010). Physico-chemical and pasting characteristics of flour and starch from *Brachystegia eurycoma* seed. *Journal of Food Technology, 8*(2), 58–66.

Ikoni, J. O., Anjah, N., & Stephen, W. H. (2012). A novel extraction method and some physicochemical properties of extractives of *Irvingia gabonensis* seeds. *Journal of Young Pharmacists, 4*(2), 66–72.

Iwuoha, C.I. (2004). Comparative evaluation of physicochemical qualities of flours from steam-processing tubers. *J. Food Chem* 85:541-551.

Imeson, A. (2010). *Food stabilisers, thickeners and gelling agents*. Wiley-Blackwell.

Kerri, W.L., Ward, C.D.W., McWatters, K.H. & Ressurreccion, A.V.A. (2000). Milling & particle size of cowpea flour and Snack Chip Quality Food Research International 34:39-45.

Kinsella, J. K. (1979). Functional properties of soy proteins. *Journal of the American Oil Chemists' Society, 56*, 242–258.

Krokida, M.JK. & Maroulis, Z.B. (1997). Effect of drying method on shrinkage and porosity. *Drying Technol. Int. J.* 15: 2441-2458.

Kinsella, J. K. (1979). Functional properties of soy proteins. *Journal of the American Oil Chemists' Society, 56*, 242–258.

Kwabena, O. K., Yaa, A., & Kipo, S. L. (2010). Physicochemical and binding properties of cashew tree gum in metronidazole tablet formulation. *International Journal of Pharmacy and Pharmaceutical Sciences, 2*(4).

Mudgil, D., & Barak, S. (2013). Composition, properties and health benefits of indigestible carbohydrate polymers as dietary fiber: A review. *International Journal of Biological Macromolecules, 61*, 1–6. https://doi.org/10.1016/j.ijbiomac.2013.06.044

Nathan, M. (2011). Industrial applications of hydrocolloids. *Journal of Food Engineering, 104*(1), 1–12.

Nebraska Wheat Board. (2009). *Wheat from field to flour*. http://c:/users/HP/Documents/wheatfromfieldtoflour.pdf

Nep, E. I., & Conway, B. R. (2011). Physiochemical characterisation of *Grewia* polysaccharide gum: Effect of drying method. *Carbohydrate Polymers, 84*, 446–453.

Nwanekezi, E. C., Ohagi, N. C., & Afam-Anene, O. C. (2001). Nutritional and organoleptic quality of infant food formulations made from natural and solid-state fermented tubers (cassava, sprouted and unsprouted yam)–soybean flours blend. *Nigerian Food Journal, 19*, 55–62.

Ohuoba, A. N., & Onwuka, G. I. (2016). Acceptability of ice cream produced using hydrocolloids from the peel and flesh of cocoyam, yam and sweet potato. *Proceedings of the 39th Annual Conference & General Meeting (Owerri 2015) of Nigerian Institute of Food Science and Technology*, 288–289.

Ohuoba, A. N., Onwuka, G. I., & Omodamiro, R. M. (2019). Effects of drying methods on physico-chemical properties of hydrocolloids isolated from peel flour of some selected root and tuber crops. *International Journal of Biochemistry Research & Review, 27*(3), 1–8. Article no. IJBCRR.51043.

Onyenekwe, P. C., Nwabueze, T. U., & Iwe, M. O. (2010). Quality evaluation of cocoyam-based snack. *African Journal of Food Science, 4*(5), 304–308.

Osundahunsi, O. F., Fagbemi, T. N., Kesselman, E., & Shimoni, E. (2003). Comparison of the physicochemical properties and pasting characteristics of flour and starch from red and white sweet potato cultivars. *Journal of Agricultural and Food Chemistry, 51*(8), 2232–2236. https://doi.org/10.1021/jf026011c

Phillips, G. O., & Williams, P. A. (2009). *Handbook of hydrocolloids* (2nd ed.). Woodhead Publishing.

Raquel, S., Jacira, R. L., Ceilo, R. S., & Renato, A. M. (2002). Cashew tree (*Anacardium occidentale*) exudates gum: A novel bioligand tool. *Biotechnology and Applied Biochemistry, 35*, 45–53.

Ratnayake, W.S., Hoover, R., & Warkentin, T. (2002). Pea Starch: Composition, structure and properties – *A Review, Starch/Starke* 54 (6): 217-234.

RSS Feed. (2014). Hydrocolloids – cooking issues. *Cook Issues*. http://www.cookissues.com/primers/hydro

Saha, D., & Bhattacharya, S. (2010). Hydrocolloids as thickening and gelling agents in food: A critical review. *Journal of Food Science and Technology, 47*(6), 587–597. https://doi.org/10.1007/s13197-010-0162-6

Scott, H. (1991). In control: Taming moisture behavior with gums and starches. *Food Design*. http://www.fooddesign.com

Size-Tao, K. W. C., & Sathe, S. K. (2004). Functional properties and in-vitro digestibility of almond (*Prunus dulcis* L.) protein isolate. *Food Chemistry, 69*, 153–160.

Taiwo, T. A. (2014). Studying of fruits, vegetables, legumes, root and tuber. *FAO*. http://www.fao.org/docrep/x5018e/x5018EOt html

Thakur, B. R., Singh, R. K., Handa, A. K., & Rao, M. A. (1997). Chemistry and uses of pectin—A review. *Critical Reviews in Food Science and Nutrition, 37*(1), 47–73. https://doi.org/10.1080/10408399709527767

Woolfe, S. (1992). *The potato in the human diet*. Cambridge University Press.