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A Comparative Study on Proximate Composition of Odisha's Local Bantal Variety Banana Peel (*Musa paradisiaca*) Flour with Cereals Flour for Their Value Addition

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: The objectives of the present endeavour was to analyse the proximate composition of locally available Bantala variety green banana peel flour (dry) and its comparison with nutrient content of cereals flour and other research findings.
Study Design: Experimental study.
Place and Duration of Study: The research was conducted in Bhubaneswar city of Odisha, India.

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Methodology: The peels of locally available plantain were collected, blanched for5minutes at 100°C, strained, dried in hot air oven for 5-6 hours at 80°C and repeated till a constant weight was obtained. Then the dried peels were powdered and used for analysis of moisture, protein, carbohydrate, fat, fibre and ash using AOAC methods.
Results: The results of the present study revealed that the local banana peel flour contain 8.65g/100g Moisture, 11.81g/100g Protein, 6.7g/100g Fat,66.05g/100g Carbohydrate, 6.79g/100g Ash, 11.5g/100g Fibre and 371.74kcal/100g calorie which proved to be a potential source of energy, protein, carbohydrate and crude fibre in comparison to research findings of other studies. It was also interesting to note that the nutrient content of banana peel flours were at par with protein and carbohydrate content of rice and rice products and wheat and wheat products (NIN, ICMR).
Conclusion: Thus findings of the present research concluded that the Banana peel flours can be utilised as a potential source of nutrition to address the challenges of food insecurity with value addition.

Keywords: Banana peel flour; proximate analysis; nutritional value; food insecurity.

1. INTRODUCTION

Utilization of food wastes is one of the most challenging areas of research now a days. In particular the use of underutilised vegetables and fruit peels in production of value-added products with adoption of due processing techniques suitable for human consumption can meet the needs of high density population all over the world. It can also act as a boon to achieve food security by improving nutrition and promoting sustainable agriculture.

The banana plant is known as the “Kalpavriksha”, or wish-fulfilling tree, in Hindu mythology because, in contrast to other plants it has all of its functional parts-leaf, stem, bloom and fruit. Banana fruits are very popular in India because of its availability throughout the year as well as due to its taste, nutritional quality and medicinal properties. It is regarded as India's second-most valuable fruit crop. Maharashtra (3924.1 thousand tonnes) and Tamil Nadu (3543.8 thousand) produce the most of banana crops compared to the national average of 30.5 tonnes/ha, Maharashtra in India has the highest productivity at 65.70 metric tons/ha, while production of banana at Odisha is 508.650 ton in 2024 (Agriculture and Farmers welfare 2012-2024 report).

The banana is an herbaceous plant that belongs to the genus Musa. The banana fruit is usually either eaten raw or ripe produced variety of foods on a large or small scale. The peel and the pulp are the two main sections of the banana fruit. The peel, the secondary product of bananas, contributes about 40% of the total weight of the fruit [1-3].

The banana peel also have rich nutritional contents and bioactive compounds that provide many more health benefits which depends on the banana cultivar, environmental circumstances, methods for extraction, and evaluation methods.

With the increase production of the fruit, the waste of their peel is also increased. According to Ahmed et al. [4], banana peels, which are about one-third of the fruit weight, are mostly thrown away as waste instead of being used for further utilization. A total of 200 tonnes of banana peel waste are generated daily. The peels are typically disposed of at municipal landfills, contributing to current environmental issues. Natural bioactive compounds are also found in banana peels, such as polyphenols, carotenoids, and dietary fibre which preventing cardiovascular disease, cancer, and other degenerative diseases.

Looking into nutritional importance of the banana peels the present research has been designed to analyse the proximate composition of banana peels of Bantala Variety (*Musa Paradisiaca*) cultivated in Odisha.

2. MATERIALS AND METHODS

2.1 Procurement and Preparation of Samples

Raw bananas were purchased from the local market of Bhubaneswar, Odisha. Fresh Bantala variety of bananas were selected in bulk and thoroughly washed with tap water. The washed bananas were peeled off and were sliced into moderate size using stainless steel knives. Next, sliced banana peels were blanched for 5 minutes at 100°C and peels were dried in hot air oven

about 5−6 hr at 80°C. The process was repeated till a constant weight was gained. The dried peels were then ground and then sieved to obtain fine Banana peel flour.

2.2 Chemical Analysis of Banana Peel Flour

Moisture: Moisture content was determined as per AOAC [5] procedure. Two gram of sample was taken in a clean, dried (at 130±3°C for 20 min) and weighed aluminium dish. The content was dried in oven at 130±3°C for 1 hour till a constant weight was obtained and cooled in desiccator. After cooling, the loss in weight was taken as moisture content and expressed in terms of per centage.

$$\text{Per cent moisture} = \frac{W2-W3}{W2-W1} \times 100$$

Where,
W1 = Weight of empty aluminium dish
W2 = Weight of aluminium dish + sample before drying
W3 = Weight of aluminium dish + sample after drying

Total Ash: Take fresh sample for the determination of total ash, rather than left over after determination of moisture. Weigh a previously clean and dried dish (W1). Weigh accurately about 5 g of powdered sample into the dish. Place with its lid underneath in the oven maintained at 130-133°C for 2 h. The time should be reckoned from the moment the oven attains 130°C after the dishes have been placed. Remove the dish after 2 h, cool in the desiccator and weigh (W2) Ignite the dried material in the dish left after the determination of moisture with the flame of a burner till charred. Transfer to a muffle furnace maintained at 550 ±25°C and continue ignition till grey ash is obtained. Cool in a desiccator and weigh. Repeat the process of heating, cooling and weighing at 30 min intervals till the difference in weight in two consecutive weighing is less than 1 mg. Note the lowest weight (W2).

$$\text{Total ash on dry basis (\% by weight)} = \frac{W2 - W}{W1 - W} \times 100$$

Where,

W = Mass in g of empty dish
W1 = Mass in g of the dish with the dried material (moisture free) taken for test
W2 = Massin g of the dish with the ash

Protein: Crude protein content was determined by the Kjeldahl method of AOAC [5]. Two gram flour sample was digested with 10 g of digestion mixture (potassium sulphate and copper sulphate in the ratio of 96:4), and 25 ml of concentrated sulphuric acid. The contents were then digested till a carbon free liquid was obtained and clean light green colour was obtained. The volume of the digested material was made up to 100 ml with distilled water. A 10 ml aliquot of digested sample was distilled with10 ml of 40 per cent sodium hydroxide solution for 15-20 minutes. The ammonia liberated was collected in a conical flask containing 25 ml of 4 per cent boric acid added with few drops of mixed indicator (bromocresol green and methyl red in the ratio of 2:1), and the distillate was then titrated against 0.1N H_2SO_4 until the end point (light pink colour) was reached. Blank determination was done by taking sucrose in place of sample. Nitrogen content in the sample was calculated using the following formula:

Per cent nitrogen =

$$\frac{(\text{Sample titre volume} - \text{blank titre volume}) \times 0.0014 \times \text{total volume of sample}}{Weight\ of\ sample \times Aliquot\ distilled} \times 100$$

Per cent Crude protein = Nitrogen % × Conversion factor (6.25)

Crude fat: It was estimated using SOCS plus method given by AOAC [5]. Two gram flour sample was weighed and placed inside the thimbles. The beakers were washed and dried in hot air oven at 100°C. The beakers were then cooled in the desiccator for about 5 minutes and weighed to obtain the weight of empty beaker (W1). A 80 ml of petroleum ether (B.P 40-60°C) was poured inside each beaker and then these beakers were attached to the SOCS plus assembly set at 80°C. Fat was extracted using petroleum ether for 45-60 minutes placing the thimbles inside the beakers. After 1 hour the recovery temperature for petroleum ether was just doubled from 80 to 120°C. Rinsing was done about two times in order to collect the remaining fat that may be present in the sample. All the beakers were then taken out of the system and placed in hot air oven for about 15 to 20 minutes at 100°C. Then they were cooled in desiccators for about 5 minutes and weighed. This was the final weight W2. The difference in the initial and final weight of the beaker was reported as fat content. The amount of extracted fat was expressed on per cent basis. Per cent crude fat was calculated as follows.

Per cent crude fat = $\frac{Weight\ of\ fat}{Weight\ of\ sample}$ ×100

Crude Fibre: Crude fibre determination was done as per the method described in AOAC [5]. The residue (2g) from crude fat determination was taken and transferred in aspout less beaker containing 200 ml of 1.25 per cent H2SO4 and boiled for 30 min. After 30 minutes, the beaker was removed and the solution was filtered through Whatman No. 54 filter paper and the residue washed with100ml hot distilled water. The residue was then boiled in 100 ml of 1.25 per cent sodium hydroxide solution for exactly 30 minutes. After 30 min of boiling, the contents were filtered through Whatman No. 54 filter paper and washed with hot distilled water using Buchner's funnel under gentle suction. The filter paper with the residue was dried in oven at105°C for 15 minutes and weighed.

Per cent crude fibre = $\frac{(W2-W1)}{Weight\ of\ sample}$ ×100

Where,
W1 = Weight of weighing aluminium dish + filter paper (g)
W2 = Weight of weighing aluminium dish+ filter paper+ crude fibre(g)

Carbohydrate: The total carbohydrate was calculated as follows: After determining the % of moisture, protein, crude fat and total ash.

Total carbohydrate = 100 - (A + B+ C + D)

Where as
A = % of w t. of moisture
B = % of wt. of protein
C = % of wt. of crude fat
D = % of wt. of total ash.

Energy: Physiological energy was calculated by the method as described by Mudambi [6]. The calorific value (Kcal/100g) of sample was calculated by summing up the product of multiplication of per cent crude protein, crude fat and carbohydrate present in the sample by 4, 9, and 4, respectively.

Energy value (Kcal/100g) = 4 x crude protein (per cent) + 4 x Carbohydrate (per cent) + 9 x crude fat (per cent)

2.3 Statistical Analysis

The values obtained from the present experimental study were tabulated with the help of percentage, mean and standard deviation. Those values are also compared with the nutritive values obtained from other research findings and also nutritive values of cereals and cereal products of NIN, ICMR (2023).

3. RESULTS AND DISCUSSION

The objective of this study was to analyze the proximate composition of locally available banana peels in Odisha. Moisture, total ash, Protein, Fat, Carbohydrate and Crude fibre were quantified by different standardized analytical methods given by AOAC and the results were discussed below.

3.1 Proximate Analysis of Banana Peels

3.1.1 Moisture content of banana peels

Table 1 and Fig. 1 depicts the moisture content of experimental banana peel flour in comparison to the moisture content of banana peels found out by various researchers. Moisture content of banana peels studied by other researchers ranges from 4.38 g/100g to 11.6%g/100g whereas moisture content of present experimental banana peel was 8.65g/100g. It was interesting to note that the moisture content of banana peels was reported to be lowest by Pasha et al. [7] i.e.6.36g/100g while the highest moisture content i.e, 11.6 g/100gwas stated by Yangilar Filiz [8] in his study.

The difference in Moisture content reported by various researchers may be due to the type of banana peel i.e. the species used or due to climatic conditions of the research area such as; Ashima Shafi had taken ripe banana peels of Kashmir for her study, Imran Pasha also took ripe banana peel of Pakisthan while Filiz Yangilar had done his work on green banana peel of Turkey.

3.1.2 Total ash content of banana peels

Table 2 revealed ash content of banana peels. It was seen that the ash content of Banana peel varied from 4.4g/100g to 9.60g/100g. The ash content of peels of present research was found to be6.79g/100g which is within the range of ash content found out by various researchers in their studies. The ash content of current experimental peels was nearer to the value given by Tsado et al. [10] who had done their study in Minna city of Nigeria by using both plantain and ripe banana peels.

Table 1. Moisture content of banana peels

Sl No.	Sample	Researchers	Moisture Content (in g/100g)
1	**Dry Banana Peel Sample (%)**	Anhwange et al. (2009) [9] Tsado et al. (2021) [10]	6.70 ± 02.22 4.38±0.03
2	**Banana Peel Powder Sample (%)**	Pasha et al. (2022) [7] Shafi et al. (2022) [11] ripe banana Yangilar Filiz (2015) [8] Garsa Ali (2022) [12] Mozeda khatun et al. (2021) [13]	6.36± 0.65 8.9± 0.03 11.6 7.53±0.03 11.2
3	**Dry Banana Peelpowder Sample (%)**	Experimental Value	8.65

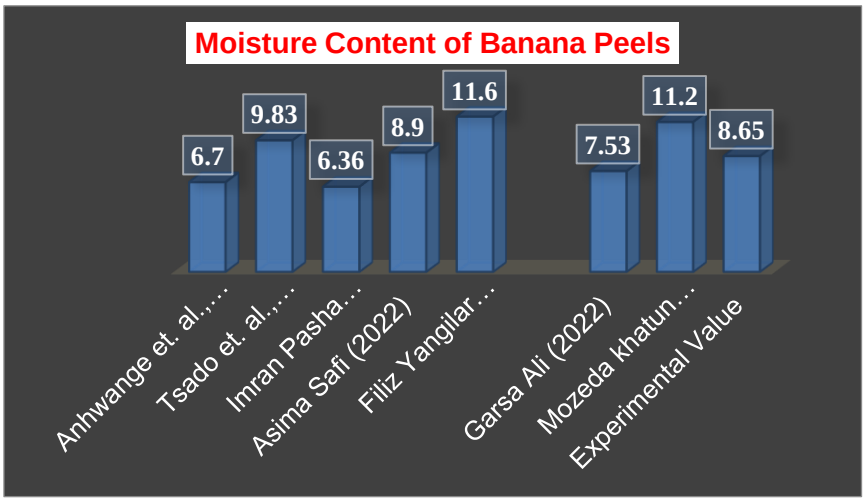

Fig. 1. Moisture content of banana peels

Table 2. Total ash content of banana peels

Sl.No.	Sample	References	Total Ash Content (in g/100g)
1	**Wet Sample (%)**	Hassan and Peh [14]	9.60 ± 0.02
2	**Dry Sample (%)**	Anhwange et al. [9]	8.50 ± 1.525
		Tsado et al. [10]	6.17±0.06
3	**Banana Peel Powder Sample (%**	Yangilar Filiz [8]	4.4±0.2
		Garsa Ali [12]	9.53±0.05
4	**Dry Sample (%)**	Experimental Value	6.79

3.1.3 Protein content of banana peels

Table 3 shows that the protein content of experimental banana peel flour which is 11.8g/100g nearer to the protein value found out by Mozeda Khatun et al. [13] i.e, 10.04g /100g, who had done their study on ripe Sabri banana peels of Bangladesh in the year 2021. Similarly Romelle et al. [15] assessed the protein content of ripe banana peels of Mysore city of India which was found as 10.44g/100g. It was interesting to note that the protein content of banana peels showed similar values irrespective of variety, areas of study and climatic condition of the locality.

3.1.4 Fat content of banana peels

The fat content for experimental banana peel flour was found to be 6.7g/100gwhich wasat par with the value reported by Hassan and Peh [14] and Khatun Mozeda et al. [13] i.e. 5.93 g/100g and 5.97g/100g respectively. Fat content of ripe banana peels was found to be only 4.52g/100g as reported by Pasha et al. [7] of Pakistan while Romelle et al. [15] reported fat content of dry

banana peel of India to be 8.4g/100g. Thus it can be concluded that the nutrient content of peels depends on the soil and climatic condition of produce.

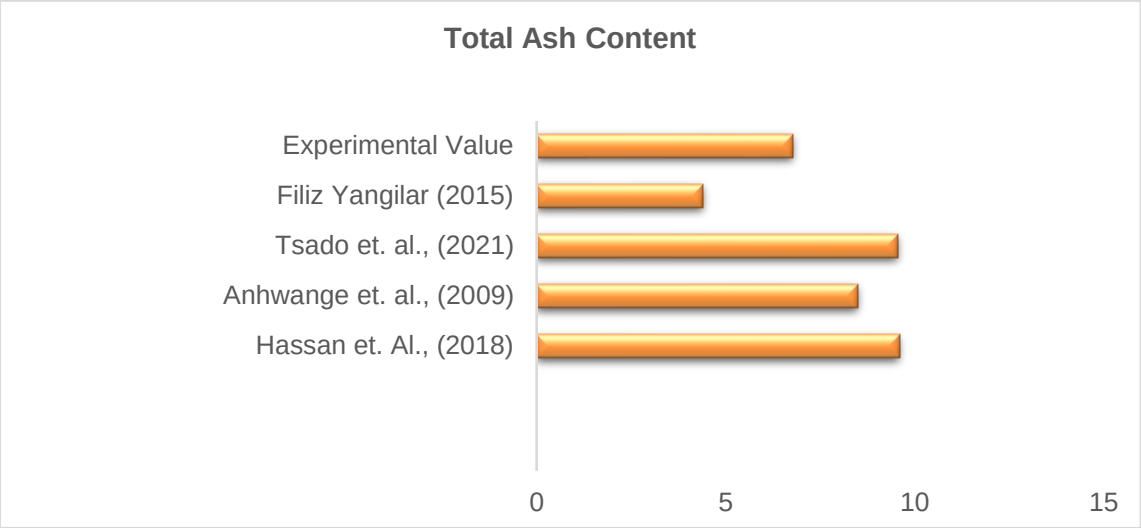

Fig. 2. Ash content of banana peels

Table 3. Protein content of banana peels

Sl No.	Sample	References	Protein Content in g/100g
1	**Dry Sample (%)**	Romelle et al. [15]	10.44 ± 0.38
2	**Banana Peel Powder Sample (%)**	Khatun Mozeda et al. [13]	10.04
3	**Dry Sample (%)**	Experimental Value	11.81

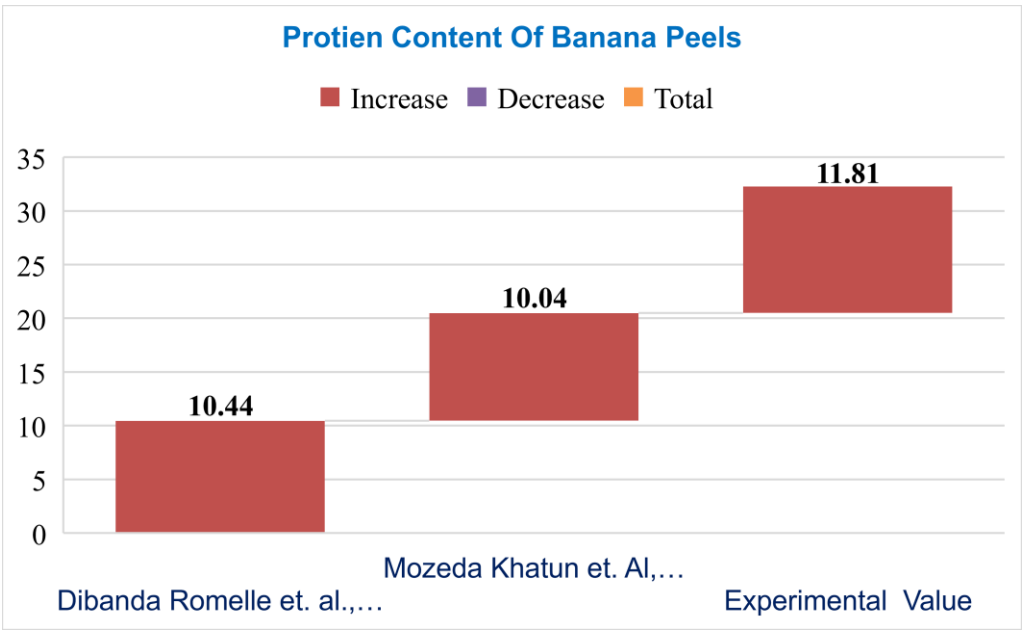

Fig. 3. Protein content of banana peels

Table 4. Fat content of banana peels

Sl. No.	Samples	References	Fat Content in g/100g
1	**Wet Sample (%)**	Hassan and Peh [14]	5.93 ± 0.13
2	**Dry Sample (%)**	Romelle et al. [15]	8.40 ± 1.15
3	**Banana Peel Powder**	Pasha et al. [7]	4.52± 0.59
	Sample (%)	Khatun Mozeda et al. [13]	5.97
4	**Dry Sample (%)**	Experimental Value	6.7

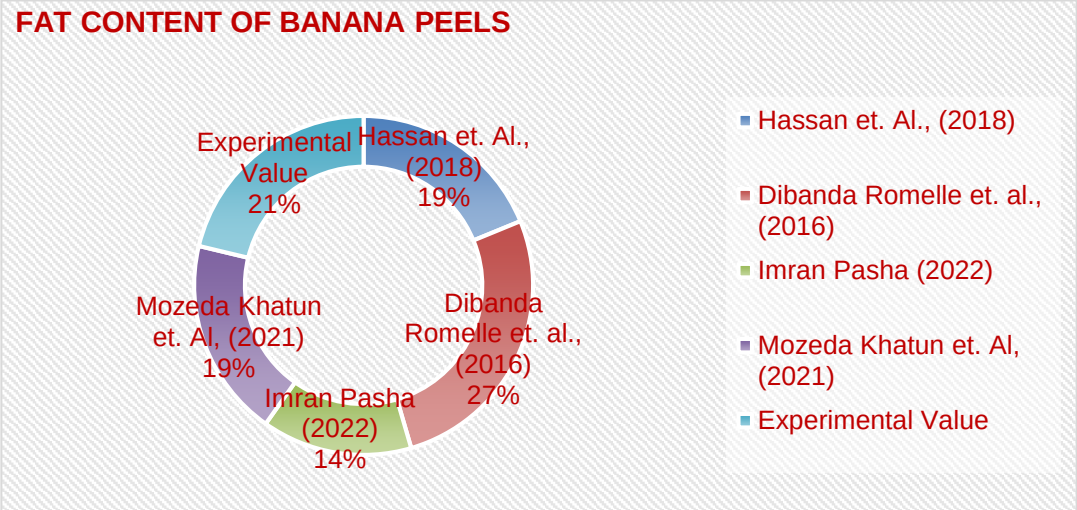

Fig. 4. Fat content of banana peels

3.1.5 Carbohydrate content of banana peels

Table 5 shows that the banana peels were high in carbohydrate content which was proved by various studies. The carbohydrate content of experimental sample was found to be66.05g/100g whereas report on the carbohydrate content of banana peels by other researchers showed the variation from 43.40g/100g to 67.25g/100g. The study performed by both Tsado et al. [10] and Garsa Ali [12] have showed the carbohydrate content in their study are at par with the value of the present experimental study i.e, 63.82g/100g and 67.25/100g respectively which may be due to the similar type of banana peel used by the researchers i.e. raw banana peels .The difference in carbohydrate content obtained by other researchers may be due the production of bananas in varied geographical region and climatic conditions.

3.1.6 Fat content of banana peels

The crude fibre content of experimental banana peel flour was found to be 11.50g/100g which was similar to the findings reported by other researchers i.e, Tsado et al. [10] was 11.81g/100g; Pasha et al. [7] was 11.20g/100g; Garsa Ali [12] was 12.38g/100g and Khatun Mozeda et al. [13] was 11.09g/100g in spite of kind of banana peels and place of cultivation and variety. It may be stated that in spite of the type, variety and the difference in place of procurement the fibre content of banana peel found by various researchers were very much comparable. So, we can say banana peels were rich source of crude fibre.

Table 5. Carbohydrate content of banana peels

Sl. No.	Sample	References	Carbohydrate Content (in g/100g)
1		Anhwange et al. [9]	59.00 ± 1.36
	Dry Sample (%)	Romelle et al. [15]	43.40 ± 0.55
		Tsado et al. [10]	63.82±0.32
2	**Banana Peel Powder**	Garsa Ali [12]	67.25±4.36
	Sample (%)	Khatun Mozeda et al. [13]	54.01
3	**Dry Sample (%)**	Experimental Value	66.05

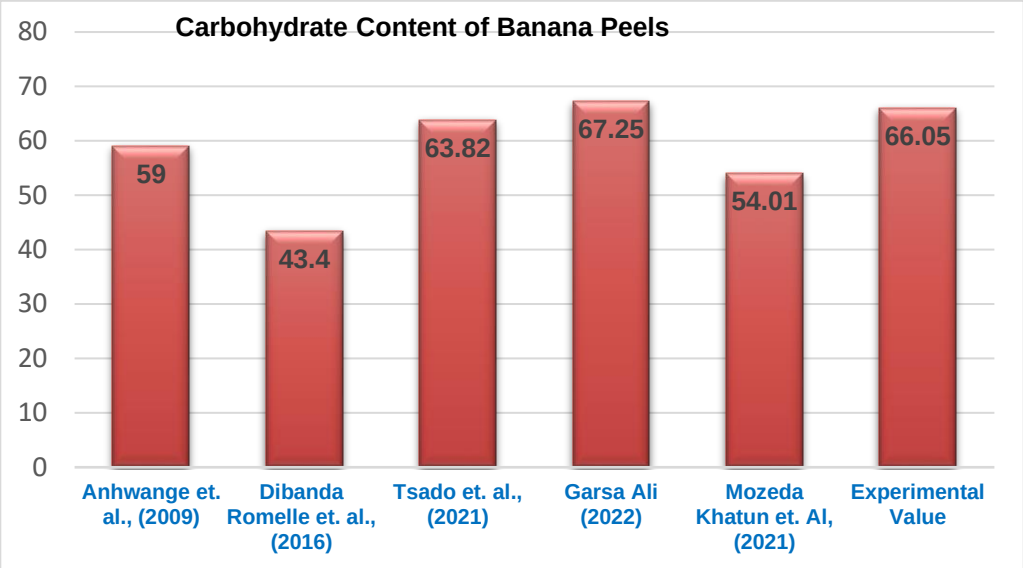

Fig. 5. Carbohydrate content of banana peels

Table 6. Crude fibre content of banana peels

Sl. No.	Sample	References	Crude Fibre Content (ing/100g)
1	Dry Sample (%)	Tsado et al. [10]	11.81 ± 0.06
2	Banana Peel Powder Sample (%)	Pasha et al. [7] Garsa Ali [12] Khatun Mozeda et al. [13]	11.20±1.73 12.38±0.92 11.09
3	Dry Sample (%)	Experimental Value	11.5

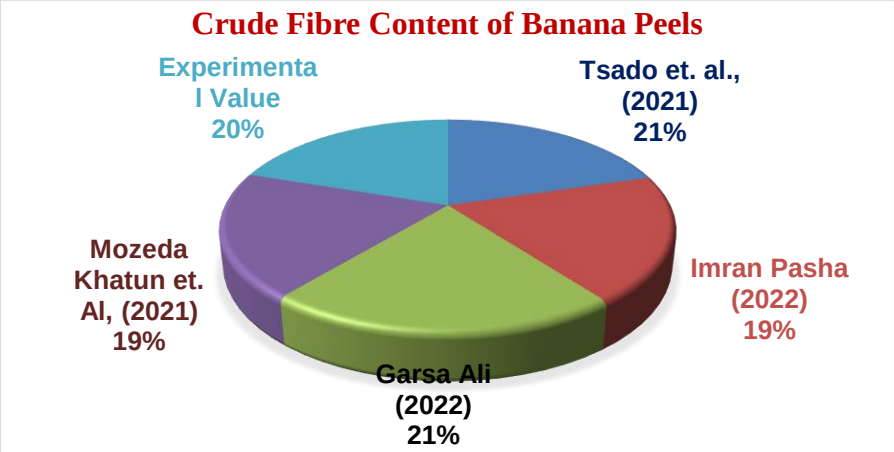

Fig. 6. Crude fibre content of banana peels

Table 7. Calorie content of banana peels

Sl. No.	Sample	References	Calorie Content (in K Cal/100g)
2	Banana Peel PowderSample (%)	Pasha et al. [7]	289.40±2.81
3	Dry Sample (%)	Experimental Value	371.74

Table 8. Comparative statement of nutrient content of cereals with experimental banana peel flour

Items	Nutrients						
	Moisture (in g/100g)	**Protein (in g/100g)**	**Ash (in g/100g)**	**Fat (in g/100g)**	**Crude Fibre (in g/100g)**	**CHO (in g/100g)**	**Energy (in K Cal/100g)**
Rice flakes (*Oryza sativa)*	6 10.36±0.53	7.44±0.35	0.85±0.13	1.14±0.11	3.46±0.32	76.75±0.96	1480±16
Rice puffed (*Oryza sativa)*	6 9.40±0.22	7.47±0.15	1.28±0.10	1.62±0.13	2.56±0.33	77.68±0.54	1514±4
Rice, raw, brown (*Oryza sativa)*	6 9.33±0.39	9.16±0.75	1.04±0.18	1.24±0.08	4.43±0.54	74.80±0.85	1480±10
Rice, parboiled, milled (*Oryza sativa)*	6 10.09±0.43	7.81±0.63	0.65±0.08	0.55±0.08	3.74±0.36	77.16±0.76	1471±8
Rice, raw, milled (*Oryza sativa)*	6 9.93±0.75	7.94±0.58	0.56±0.08	0.52±0.05	2.81±0.42	78.24±1.07	1491±15
Wheat flour, refined *(Triticum aestivum)*	11.34±0.93	10.36±0.29	0.51±0.07	0.76±0.07	2.76±0.29	74.27±0.92	1472±16
Wheat flour, atta *(Triticum aestivum)*	11.10±0.35	10.57±0.37	1.28±0.19	1.53±0.12	11.36±0.29	64.17±0.32	1340±7
Experimental Banana peel flour *(Musa paradisiaca)*	**8.65**	**11.81**	**6.79**	**6.7**	**11.5**	**72.41**	**371.74**

3.1.7 Calorie content of banana peels

The calorie content of experimental banana peel flour (*Bantal variety*) was found to be 397.18 KCal/100g, which was more that the caloric value of wheat flour and other commonly used flours and also the finding of the other researches.

3.1.8 Comparative statement of Nutrient content of Cereals (IFCT, NIN, ICMR, 2017) with experimental banana peel flour

Table 8 depicts comparative statement of the nutrient content of cereals with experimental banana flour. It was interesting to note that protein, ash, fat, crude fibre and calorie content of banana peel flour was more in comparison to rice and rice products and wheat and wheat products as well. Carbohydrate content of banana peel flour was found to be lesser in comparison to rice, wheat and their products however the difference was very negligible. Thus it can be concluded that the banana peel flour can be utilized as a potential food source at par with the cereal flours for addressing food insecurity and nutrition sustainability.

4. CONCLUSSION

Banana peels are generally considered as a vegetable waste without looking into its nutritional quality. The present research focused on studying its nutritional potentiality and an attempt has been made to analyse the proximate composition of banana peel flour (Bantal variety) profusely available in Odisha and discarded as waste. Result of the study revealed that the banana peel flour contains more amount of carbohydrate, protein, fat, calorie, ash and fibre in comparison to cereals and its products. Surprisingly it was also observed that the experimental flour contain the nutrients at par with the research findings of other researchers of different countries. Thus banana peel flour can be utilized to prepare energy dense foods and foods enriched with other nutritional potential to meet the challenges of food security to attain sustainable development goals. Further in depth research in this direction need to be conducted for utilisation of these orphan banana peels instead of making it a waste rather a treasure house of nutraceuticals for betterment of the society.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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