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Utilization of unripe banana (*Musa acuminata*) peel flour for value addition

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Abstract
Unripe Banana (*Musa acuminata*) peel have a lot of nutritional content which we are discarding as waste. Conversion of unripe banana peel (UBP) to flour will convert it into value-added product in the food industry. The present study is to utilize the unripe banana peel flour (UBPF) as a functional ingredient for preparation of cookies and to analyse the chemical composition and organoleptic test of cookies that are made with UBPF. Cookies were prepared by refined wheat flour in the (90:80:70:60): UBPF (10:20:30:40) and: sugar was replaced by honey in the (50:40:30) respectively. The proximate analysis and sensory parameters of those cookies were compared with control sample (CS) cookies where no UBPF was added (0% substitution). The moisture, Ash, Protein, Fiber, Fat, Carbohydrate content of cookies are 5.4, 2.1, 4.6, 2.9, 14.4, 73.5 respectively and up to 20% incorporation of UBPF, 40% of honey in cookies was acceptable as per the results. UBPF can be recommended for the value addition, nutraceuticals and as a supplementary flour for the preparation of various delicious recipes in food processing industry.

Keywords: Unripe banana peel flour (UBPF), functional ingredient, cookies, proximate analysis

1. Introduction
Agricultural by-products are getting more attention from many researchers and food manufacturers by converting the by-product into food. UBP, an agro waste is neglected all over the world as a useless material that causes waste management problems. The UBP can be commercialised because qualitatively and quantitatively it contains more antioxidants than the pulp. UBP extract has more antioxidants and phenolic components than pulp, indicating that the peels could be used in a broad range of foods and nutritional supplements. As for antioxidants, they are known to have beneficial health-promoting properties such as strengthening the body immunity system, reducing the risk of metabolic diseases and delaying the ageing process. UBP represents about 40% of total weight of the fresh fruit. UBP is a rich source of starch (3%), crude protein (6-9%), crude fat (3.8-11%), total dietary fibre (43.2-49.7%), and polyunsaturated fatty acids, particularly linoleic acid and α-linolenic acid, pectin, essential amino acids (leucine, valine, phenylalanine and threonine), and micronutrients (K, P, Ca, Mg) (Mohapatra D, *et al*., 2010) [4].
Unripe banana contains most of the essential vitamins including vitamin -A, C and B6, important minerals, good source of fat, free dietary fibre and a rich source of calories. UBP also contains potassium, calcium, sodium, iron, magnesium, copper, bromine. (Someya S, *et al*., 2002) [12]. UBP are good sources of total starch (TS) (73.4%), resistant starch (RS) (17.5%), protein, fat and micronutrients (Juarez-Garcia *et al*., 2006) [5]. So that consumption of UBPF may play a significant role in human health. Dietary fibre is well known in reducing the risk of diseases such as constipation, irritable colon, colon cancer, cardiovascular diseases, and diabetes.
Bakery industry is one of the major food industries in India. Cookies are widely consumed as ready to eat and convenient foods throughout the world which gives more nutrient than any other single food sources. (Raihan and Saini, *et al*., 2017) [11]. Now-a -days, cookies represent the lea ding category of snack foods in the major parts of the world. (Laura and Eric, *et al*., 2014) [8]. Traditionally, cookies making processes are quite simple with some basic ingredients that consist of flour, sugar and eggs. (Laura, Eric and Emelem, *et al*., 2013) [7]. Cookies hold an important position in snack foods due to variety in taste, crispiness and digestibility.

2. Materials and Methods

2.1 Procurement of raw materials

Ra w materials like unripe banana, honey, Maida flour and other ingredients were purchased from the local market at Bodhan, Nizamabad district, Telangana state.

2.2 Preparation of unripe banana peel flour

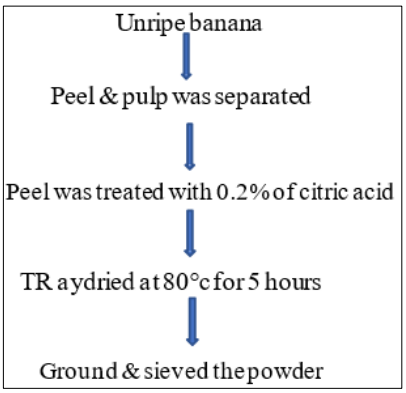

Fig 1: Flow chart for Preparation of UBPF

2.3 Development of cookies using UBPF

The ingredients for the preparation of cookies are refined wheat flour, UBPF, honey, margarine, baking powder. Cookies were prepared by blending refined wheat flour and Unripe banana peel flour in the ratios of 100:0, 90:10, 80:20, 70:30, and 60:40. And sugar was replaced by honey in 30%, 40%, and 50% respectively for the above-mentioned compositions.

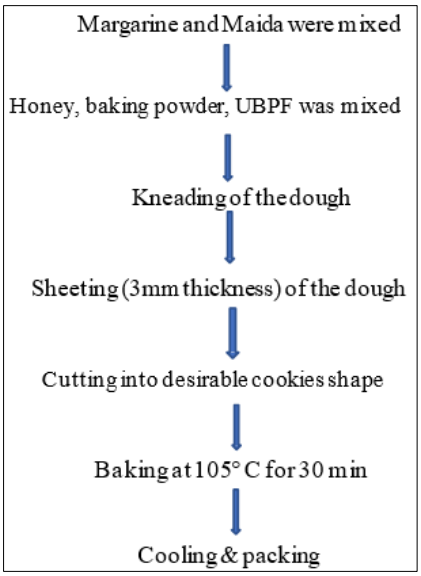

Fig 2: Flow chart for preparation of cookies

Table 1: Proportions, treatments for the preparation of cookies

S. No	Ingredients	CS	Sample-1			Sample-2			Sample-3			Sample-4		
			S1-1	S1-2	S1-3	S2-1	S2-2	S2-3	S3-1	S3-2	S3-3	S4-1	S4-2	S4-3
1	Refined wheat flour(g)	100	90	90	90	80	80	80	70	70	70	60	60	60
2	UBPF	-	10	10	10	20	20	20	30	30	30	40	40	40
3	Honey	-	50	40	30	50	40	30	50	40	30	50	40	30
4	Sugar	50	-	-	-	-	-	-	-	-	-	-	-	-
5	Margarine	55	55	55	55	55	55	55	55	55	55	55	55	55
6	Baking Powder	2	2	2	2	2	2	2	2	2	2	2	2	2

2.4 Chemical analysis of cookies

2.4.1 Estimation of Moisture content

Moisture content of cookies was measured by using standard method (AOAC 2005).

2.4.2 Estimation of Ash content

The ash content of cookies was measured by using standard method (AOAC 2005).

2.4.3 Estimation of Fat Content

The Fat content of cookies was measured by using standard method (AOAC 2005).

2.4.4 Estimation of Protein Content by Kjeldahl method

Proteins are abundant components in food. Nitrogen is the most distinguishing element present in proteins. Proteins can be classified by their composition, structure, biological function or solubility proteins. The analysis of proteins is complicated by the fact that some food composition possesses similar physicochemical properties. Protein nitrogen can come from free amino acids, small peptides, nucleic acids, phospholipids, amino sugars, porphyrin, some vitamins, alkaloids, and uric acid, urea and ammonium ions. Therefore, the organic nitrogen in foods would represent nitrogen primarily from proteins and to a lesser extent from all organic nitrogen containing non-protein substances.

Reagents required: For digestion

1. 98% pure concentrated H2S04: Take 98 ml of sulphuric acid and dilute to 100 ml- 10 ml per sample
2. Catalyst mixture or digestion mixture or activator in 5:1 ratio - 5 grams for each tube.

i) K2S04 or Na 2S04 (100g)
ii) Copper sulphate (20g)

For distillation

1. 40% Na OH: 400 g Na OH in 1: 1 of distilled water -40 ml per sample.
2. 4% boric acid in (g): distilled water -25 ml per sample.
3. Mixed indicator: 2 Parts of methyl red Indicator, 1 part of bromocresol green.

For titration: 0.1N HCl or 0.1N H2SO4 Standards: Take 36.5ml of hydrochloric a cid or 49ml of sulphuric acid and mix in 1litre of distilled water.

Procedure

Sample preparation

Solid foods are to pass a 20-mesh screen. Sample for analysis should be homogeneous.2ml of liquid samples or 0.2-0.3gms solid samples are sufficient for digestion.

Digestion

Nitrogen in sample like plant, soil, meat, fertilizers etc. exists

in a very complicate bonding structure. During digestion these complicated structures are broken into simple structures and thereby release nitrogen in the form of ammonium radical (NH).

1. Weigh 0.5gm of plant sample or 1 gm of soil sample or 2 ml of liquid sample and transfer it to the digestion tube. Add 10-15ml of conc.H2S04 and 5-7gm of digestion activator to the sample. Load the digestion tubes into the digester and heat the digestion block.
2. It is advisable to maintain the blank temperature between 360 ℃ and 4 10 ℃. The effective digestion starts only a t 360 ℃ and to 410 ℃. The chance of nitrogen escape is unavoidable. The sample turns colour less or light green color.

Neutralization and Distillation

During distillation the ammonium radicals are converted to ammonia under excess alkali conditions. The digested samples are heated by passing steam and ammonia liberated due to addition of 40% NaOH dissolved in 4% boric acid. The boric acid consisting of ammonia is ta ken for titration. The acid digestion mixtures dilute and made strongly alkaline with Na OH.

Ammonia is libera ted during the process a s following

$$(NH_4)_2SO_4+2NaOH \longrightarrow 2NH_3+Na_2SO_4+2H_2O$$

Titration

Titrate the solution of boric acid and mixed indicator containing the distilled off ammonia with the standardized 0.1N HCL. Determine the titration value of blank solution of boric acid and mixed indicator.

$$NH_3+H_3BO_3 \longrightarrow NH_4{:}H_2BO_3+H_3BO_3\,(EXCESS)\;2NH_4H_2BO_3+H_2SO_4 \longrightarrow (NH_4)_2+2H_2BO_3$$

Crude protein (%) = N×6.25

2.4.5 Estimation of Crude fiber content Chemical reagents

- **0.128M sulfuric acid:** dilute 3.49ml H2 SO4 in 500ml distilled water
- **0.313M sodium hydroxide:** Dissolve 6.25g Na OH pellets in 500 ml water.

Boiling in acid

Measure 200 ml of 0.128M Sulfuric acid and Weigh 2g of sample. Transfer the sample into the conical flask to mix with acid solution. Place the flask on a hot plate and boil the sample for 30 min. Shake the flask periodically to ensure the proper boiling of sample. After 30 minutes of boiling set a funnel with muslin cloth. Filter the boiled sample to drain the acid solution. Wash the filtrate with hot water to remove the acid residue completely. Remove the filtrate carefully and place in the base solution for boiling.

Boiling in base

Measure 200 ml of 0.313M Na OH solution. Pour the Na OH solution into the conical flask and add the filtrate which is already boiled in. Rotate the flask to mix and place on hot plate. Boil the sample with periodic agitation.

Aga in, filter the sample to drain Na OH solution. Wash with hot water to remove NaOH residue completely. Collect the filtrate in a clean & dried crucible till no filtrate is left.

Drying

Place the crucible on hot plate to evaporate the excess water. Now place the crucible in Hot air oven. Set the temperature at 130 ℃ for 2 hrs. Take out the sample from the oven and cool in desiccator. Take the weight of crucible containing fiber.

Incineration of fibre

Place the crucible inside of muffle furnace. Close the door. Set the temperature at 550℃ for 2h. Note the weight of crucible.

Calculation

Crude fiber % = W1 – W2 /Ws x 100 Where, Ws = weight of the sample W1 = weight of crucible with fibre W2 = weight of crucible with ash.

2.4.6 Estimation of carbohydrates content

Carbohydrates can be defined as chemically as neutral compounds of carbon, hydrogen and oxygen. Carbohydrates come in simple forms such as sugars and complex farms such as starches and fibre. The body breaks down most sugars and starches into glucose, a simple sugar that the body can used to feed its cells. The formula to estimate carbohydrate content is as follows:

% Carbohydrate=100- (% Moisture + % Ash +% Fat + % Protein) 3.Results and Discussion

3. Results and Discussion

3.1 Proximate analysis of cookies

The parameters like moisture, ash, protein, fiber, fat, carbohydrate content of cookies was evaluated in food quality and safety assurance lab.

Table 2: Proximate analysis of cookies

S. No	Parameters	CS	Sample-1			Sample-2			Sample-3			Sample-4		
			S1-1	S1-2	S1-3	S2-1	S2-2	S2-3	S3-1	S3-2	S3-3	S4-1	S4-2	S4-3
1	Moisture (%)	2.0	5.6	4.8	3.7	6.3	5.4	4.8	9.1	8.6	7.3	10.6	10.2	8.4
2	Ash (%)	1.5	2.3	1.7	1.2	3.2	2.1	1.9	4.6	3.4	2.8	5.7	4.2	3.3
3	Protein (%)	6.8	5.8	5.7	5.6	4.9	4.6	4.3	4.2	4.0	3.8	3.9	3.7	3.5
4	Crude fiber (%)	0.5	2.4	1.6	1.4	3.1	2.9	2.6	3.7	3.4	3.2	4.4	4.2	4.0
5	Fat (%)	15.6	14.8	14.6	14.5	14.7	14.4	14.3	14.2	13.8	13.6	13.9	13.7	13.5
6	Carbohydrates (%)	74.1	71.5	73.2	75.0	70.9	73.5	74.7	67.9	70.2	72.5	65.9	68.2	71.3

It was observed that by increasing the UBPF content the parameters like moisture, ash, crude fiber content of cookies was increased. And protein, fat content of cookies was decreased. Moisture content of Cookies made with foxtail millet flour is 2.01 (Kumaran B. D, *et al*., 2022) [6], Ash content of Cookies made with cassava flour is 2.78. (Chakrabarti T, *et al*., 2017) [3], Protein content of Cookies made with coffee pulp waste is 2.55 (Moreno J, *et al.*, 2019) [10], Crude fiber content of cookies made with mango kernel flour is 1.96 (Alkozai. A, *et al*., 2018) [1], Fat content of cookies made with orange peel powder is 15.12% (Zaker M. A, *et al.*, 2016) [13], Carbohydrates content of cookies made with pine apple flour is 80.13% (Lopez-Fernandez M, *et al*., 2021) [9].

3.2 Sensory evaluation of cookies

Table 3: Sensory evaluation of cookies

S.no	Sensory Details	CS	Sample-1			Sample-2			Sample-3			Sample-4		
			S1-1	S1-2	S1-3	S2-1	S2-2	S2-3	S3-1	S3-2	S3-3	S4-1	S4-2	S4-3
1	Taste	8.8	7.9	7.5	6.9	7.4	7.2	6.5	6.8	6.4	5.9	6.1	5.9	5.2
2	Texture	8.6	7.8	7.6	7.5	7.4	7.7	7.4	7.5	7.2	6.9	6.8	6.7	6.5
3	Colour	8.4	7.9	7.6	7.4	7.3	7.5	7.2	6.9	6.8	6.7	6.5	6.3	6.1
4	Flavour	8.5	7.0	7.1	7.3	7.2	7.6	7.3	6.9	6.7	6.6	6.4	6.2	5.9
5	Mouth feel	8.9	7.2	7.0	6.8	7.1	7.4	7.2	6.8	6.7	6.5	6.3	6.2	6.1
6	Overall acceptability	8.8	7.1	7.0	6.9	7.2	7.5	6.9	6.8	6.8	6.4	6.2	6.1	6.0

4. Conclusion

As per the chemical analysis and sensory evaluation the most acceptable formulation in cookies is S2 (80:20) with 40% of honey. These formulation shows the best results in overall acceptability of products. Therefore, 20% of the peel flour was acceptable in cookies formulation.

From the study it can be concluded that UBPF is the potential source of all the major nutrients. Due to its high nutrient content, it can be a valuable acid, functional ingredient used in preparation of variety of products. The products made with UBPF was found acceptable in terms of taste, colour and flavour so UBPF can be recommended for the value addition, nutraceuticals and as a supplementary flour for the preparation of various delicious recipes in food processing industry.

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