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Arya Krishnan S
Department of Food Technology, TKM Institute of Technology, Kollam, Kerala, India

Nukasani Sagarika
Department of Food Technology, TKM Institute of Technology, Kollam, Kerala, India

Sona Sara Eldose
Department of Food Technology, TKM Institute of Technology, Kollam, Kerala, India

Jabir Mohammed
Department of Food Technology, TKM Institute of Technology, Kollam, Kerala, India

Josna K Johnson
Department of Food Technology, TKM Institute of Technology, Kollam, Kerala, India

Correspondence
Arya Krishnan S
Department of Food Technology, TKM Institute of Technology, Kollam, Kerala, India

Development of a satietic composition using fish protein concentrate and banana peel flour

Arya Krishnan S, Nukasani Sagarika, Sona Sara Eldose, Jabir Mohammed and Josna K Johnson

Abstract
The temptation to over eat is everywhere, so in present situation it is very difficult to control how much we eat and maintain a healthy weight. There are countless weight loss diets around us to try, but dieting leaves us feeling hungry and deprived. Therefore another way is required to control how much we eat without going hungry. The feeling of satiety can play an important role in controlling how much we eat. Banana peel flour (BPF) and fish protein concentrate (FPC) were used as raw materials for preparation of satietic composition. The results obtained in this study indicated that the banana peel can be used in the food industry for the purpose of value addition of fibre. 100g of banana peel will provide a yield of 14.74g powder after drying. FPC made from tuna fish contains more than 70% protein, which is 74.4 g per 100g. Significant differences in odor, lipid content, stability, taste, nutritional value, and functional properties are obtained depending upon the processing conditions and the species of fish used. The products resulting from these processes have improved functional properties. Some of these appear to be particularly promising for use in certain foods because of their functional attributes.

Keywords: Satietic composition, dietary fibre, appetite

Introduction

Satiety is the feeling of fullness that persists after eating potentially suppressing further energy intake until hunger returns and satiation is the process that leads to the termination of eating which may be accompanied by a feeling of satisfaction (Benelam, 2009) [4]. In recent years the food market has seen a rise in the sale of enhanced satiety products, which claim to be effective at starving off hunger and seem to be well received by the public. Taking this integrated approach to satiety, leads to the development of enhanced satiety food products.

Fish Protein Concentrates (FPC's) are defined as those products obtained from fish in which the protein is more concentrated than the original raw material. The protein content of FPC depends on the raw material used and the extent to which water has been removed, but the products normally contain at least 65 per cent protein. Tuna is a good source of protein. Cooked tuna has 25.5 grams of protein in a 3-ounce serving. It is a widely used fish having high omega- 3 fatty acid content.

Another food ingredient that can have beneficial effects on satiety responses is dietary fiber. Fibre is thought to affect satiety in many ways, depending on the fibre type, and relating to its ability to bulk foods, increase viscosity, gel in the stomach and ferment in the gut (Slavin and Green, 2007) [8]. Currently peels of variety of fruits are used as a natural source of antioxidants and dietary fibre. With these grounds, banana peel has attracted attention and recent reports suggested that it possess a very good source of dietary fibre and antioxidants (Arun *et al*., 2015) [3]. Banana peel flour (BPF) potentially offer new products with standardized compositions for various industrial and domestic uses (Emaga *et al*., 2007) [5]. Plantain cultivar *Nendran*is one of the important agricultural crops of the region and peel can be proven as a source of antioxidant dietary fibre, as well as pectin (9-23%). It also provide excellent nutritional status to contribute various health benefits, it comprises diarrhoea, dysentery, intestinal lesion, in ulcerative colitis, diabetes, nephritis, gout, cardiac disease, hypertension etc. (Arun *et al*., 2015) [3].

The present work relates the use of FPC and BPF as the sources of protein and dietary fibre respectively for the development of the satietic product with the following objectives:

- Todevelop a satietic product using fiber rich banana peel powder and fish protein concentrate

- To conduct the Satiety test of the developed product.

Materials and Methods

Preparation of banana peel flour (BPF)

The banana fruit was first washed and separated into peel. The peels were again washed, pretreated with cold water containing 0.5 % citric acid for 10 min, drained and sliced into small pieces. It was then dried in an oven at 50°C for16–24h. Dried peels were grinded in a mixer andthen passes through 60 mesh screen to obtain banana peel flour. The powder obtained is packed in air tight containers and stored under chilled condition.

Analysis of BPF

- **Water holding capacity:** It is expressed as the total amount of water which can be absorbed by 100g of flour. The 25 ml of distilled water and 1 g of sample was taken in tubes of 30 ml and allow standing at ambient temperature for 15 min. Then the tubes were centrifuged at 4000 rpm for 20 min, and then the supernatant was allowed to drain. The residue remains after draining of excess water was weighed and Water Holding Capacity of sample was determined as gram of water/gram of sample.
- **Moisture content:** For this, oven dry the sample in a hot air oven to a constant weight at 105°C to determine the moisture present.
- **Total protein:** The Micro-Kjeldahl procedure was adopted for the determination of protein. Nitrogen (N) was estimated using the Kjeldahl method and the crude protein (CP) content can be calculated as (N × 6.25; method 981.10; (AOAC, 1990).
- **Crude fibre:** Five gram of sample was weighed into a 500 ml beaker, 200 ml of boiling 0.2 to 0.5 N sulphuric acid was added. The mixture was boiled for 20 minutes keeping the volume constant by adding water at frequent intervals at the end of the period, the mixture was filtered through muslin cloth and the residue was washed with hot water until it is free from acids. The mixture was transferred into a beaker containing 200 ml of boiling 0.313N sodium hydroxide. After boiling for 30 minutes the mixture was filtered through a muslin cloth and the residue was washed with hot water till it is free from alkali. This was followed by washing with alcohol and ether and the contents are dried overnight at 80°C to 100°C and weighed.
  The crucible was heated in a muffle furnace at 600°C for 2 hours and weigh again. The difference in weight between the empty crucible and the sample represent weight of the sample.
- **Total Titrable Acidity (TTA):** Approximately 2g of dried peel powder was extracted with 30 ml distilled water and 20 ml methanol at 45°C for 15 min in a water bath. The mixture was filtered, and 4 ml of filtrate was pipetted into a flask containing 5 ml distilled water followed with the addition of 3 drops of 1% phenolphthalein. The mixture was then titrated against 0.1 N NaOH until the faint pink end point persisted for 30 seconds and TTA was expressed as % of malic acid.
- **Ash content:** The ash content was determined based on the procedure suggested by (AOAC, 1995) [2]
- **Total soluble solids (TSS):** It was measured as ° Brix at 20°C with Hand Refractometer.
- **Calorific value:** This was measured using bomb calorimeter. The equation to determine calorific value of fuel is given by

$$W \times (T_2 - T_1) = mCv$$

Where, W = Energy equivalent of calorimeter assembly = 9375 J/°C,
Mass of fuel burnt (m) = $m_2 - m_1$
Temperature rise = $T_2 - T_1$,
CV = Calorific value of fuel.

Preparation of fish protein concentrate

Freshly collected tuna fish is washed, dressed and weighed. Cook it in steam or boiling water for 30 minutes. Spread in trays and cool under fan. Weigh again and separate meat from bones and skins by hand picking. Break into small flakes and allow water to leach. Put meat into a stainless steel vessel and pour 3-4 times its volume fresh water. Stir it using a mechanical stirrer for a period of about 5 min. Stop stirring and allow the meat to settle for few min. Decant to remove the supernatant. Attach a condenser to the flask and reflux at a temperature below 80°C for 15 min. Transfer to a cloth bag, strain out the liquid by pressing. Repeat refluxing with fresh solvent followed by straining until the material becomes sufficiently free of oil, water etc. Vacuum dry at a temperature of 50^0 C until it is dry enough and free of any residual solvent. Pulverize it using a dry grinder. Weigh and Pack in plastic bottles and store at room temperature.

Proximate analysis of FPC

- **Ash content:** Take 1g of the dried material in a crucible. Ignite it slowly using an electrical furnace, until it is completely charred. Keep the sample at 600 ^{0}C in a muffle furnace for 4 hours. Finally the weight of the ash is taken after cooling in a desiccator.
- **Moisture content:** Weigh 1g of the sample and kept in hot air oven at 100^0C for 4 hours. Weigh the sample for every half an hour, after cooling in the desiccator, until constant weight is obtained.
- **Total protein:** The protein content is determined by the Micro-Kjeldahl method as reported by James (1995) [6].
- **Crude fat:** Crude fat was determined by using soxhlet reflex flask method.
  The fat content was calculated as:

$$\% \text{ fat} = (W_2 - W_3) \div (\text{Weight of sample}) \times 100$$

Where, W_3 = Weight of empty extraction flask
W_2 = Weight of flask and oil extract

Product preparation

The recommended amount of fiber for a 2000 kcal diet is 25g per day and that of protein is 46g per day (www. Livestrong.com) [8]. According to studies, protein intake around 30% of calories may be optimal for weight loss. This amounts to 150 g/day for 2000 calorie diet. Based on these factors the following five compositions have been set COMP – 1(30 g protein and 2 g fiber); COMP – 2 (30 g protein and 3 g fiber); COMP – 3 (30 g protein and 7 g fiber); COMP – 4 (15 g protein and 7 g fiber); and control COMP – 5 (20 g protein and 7 g fiber).

Satiety test

Self-reported measure of appetite, used to monitor hunger, fullness and motivation to eat. It is recorded both before and at intervals after the preload given to monitor changes in reported satiety. A combined satiety score (CSS) was calculated as composite satiety score using the measures for fullness, desire to eat, hunger and prospective food consumption (PFC). The formula reflected the 4 questions on the motivation-to-eat questionnaire. They are:

1. How much is your desire to eat? (Very weak / Very strong)
2. How hungry are you? (Not at all hungry / As hungry as I have ever felt)
3. How satisfied are you? (Completely empty / Cannot eat another bite)
4. How much could you eat? (Nothing at all / A lot)

$$\mathbf{CSS} = [\boldsymbol{Fullness} + (\mathbf{100} - \mathbf{Desire\ to\ eat}) + (\mathbf{100} - \mathbf{Hunger}) + (\mathbf{100} - \mathbf{PFC})] / \mathbf{4}$$

Measuring food intake

- Food of known calorie that can be consumed ad libitum is given to the subject after the test meal (predetermined time-2hr)
- Ad libitum food – chapatti (341 Kcal/100g)

Results and Discussion

Preparation of banana peel flour

After completing the general procedures for banana peel flour production, the following results were obtained,

Powder yield (%) - 14.74

Energy (kcal/100g) - 522±1.081

That is from 100g of banana peel we obtained a yield of 14g of banana peel flour having an initial moisture content of 9.7±0.40g. The flour obtained had a dark brown colour which can be prevented by dipping the raw peel in citric acid before drying.

Proximate Analysis of BPF

The proximate analysis of Banana peel flour resulted in the following values:

Table 1: Proximate Analysis of BPF

S.No.	Parameter	Results
1.	Moisture (%)	9.7± 0.40
2.	Ash (%)	8.667± 0.57
3.	Total Protein (%)	7±0
4.	Crude Fibre (%)	16±0

Values are expressed as mean ± standard deviation

Moisture Content

The value of moisture obtained from the peel flour of Nendran variety is slightly higher (9.7%).This may be due to the improper storage condition of the developed flour.

Ash Content

The value of ash obtained meet with the study conducted by (Anhwange *et al*., 2009) [1]. This shows that developed flour contain enough mineral content. The minerals include iron, calcium, potassium, magnesium, phosphorous etc.

Total Protein

The protein content of the developed Nendran peel flour is higher compared with previous studies. It is found to be 7g in 100 g of sample.

Crude Fibre

The crude fibre content is slightly higher compared with the study conducted by Arun *et al*. (2015) [3]. The variation in result may be due to the geographical conditions under which the crop has been cultivated.

Chemical Analysis of BPF

Table 2: Chemical Analysis of BPF

S. No	Parameter	Results
1.	Total titratable acidity (%)	0.1±0.05
2.	Water holding capacity (g)	5.04±0.12
3.	Total soluble solids (ºBrix)	2±0.03

Values are expressed as mean ± standard deviation

Total Titratable Acidity (TTA)

The TTA (0.1%) of the flour obtained from this variety is within the limit as per the study conducted by Khawas *et al*. (2014) [7]. TTA lies in the range of 0.15-0.3.

Water Holding Capacity

The water holding capacity of Nendran peel flour is found to higher (5.04g) in comparison with other studies.

Total Soluble Solids

By analyzing the previous studies, we observed that the value of TSS (2 ± 0.03) have slight variation from the limit of 1.53 to 1.90.

Fish Protein Concentrate

After completing the general procedures for the production of FPC, powder yield and energy has got the following results:

Powder Yield (%) - 15.8

Energy (Kcal/100g) - 618.6±1.652

Proximate Analysis of FPC

Table 3: Proximate Analysis of FPC

S. No	Parameter	Results
1.	Ash (%)	1.667±0.57
2.	Moisture (%)	9±0.021
3.	Total protein (%)	74.4
4.	Crude fat (%)	2.1

Values are expressed as mean ± standard deviation

Graphical representation of energy consumption

The values of energy consumptions for control and different compositions is graphically analyzed below:

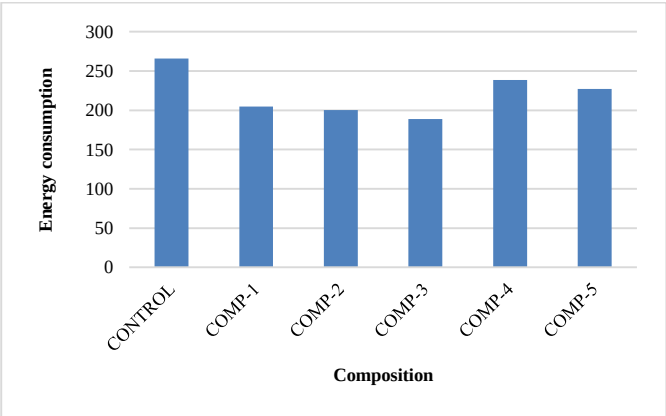

Fig 1: Energy Consumption

From the graph showing the values for energy consumption, it is clear that the value is higher for the control compared with all other compositions. Composition 3 is havingcomparatively less value for energy consumption, i.e. 188.686 kcal, which makes it clear that composition 3 is more satiating among all other compositions.

Graphical representation of satiety score

The satiety score for control and all the compositions are graphically described below:

From the graphical analysis of satiety score for control and all the compositions, we can infer that composition 3 shows the peak value of satiety score. By analysing the satiety score at different time intervals, i.e. after 1 hour and 2 hour, we can see that value is higher for composition 3 when compared with control and all other compositions. Based on the complete study conducted and graphical analysis at different stages we can infer that composition 3 is the best satietic composition with satitety score 74 ± 4.583 and 72 ± 4.582 after 1 hour and 2 hour respectively. The satiety score is maintaining at a high value even after 2 hour and the ad libitum energy intake after consumption of this composition was 188.686±5.139 kcal, which is lower than control and all other compositions. Therefore it is clear that composition 3, i.e. test food with 30g protein and 7g fiber is more satietic and the time of return of hunger for this composition is also very long.

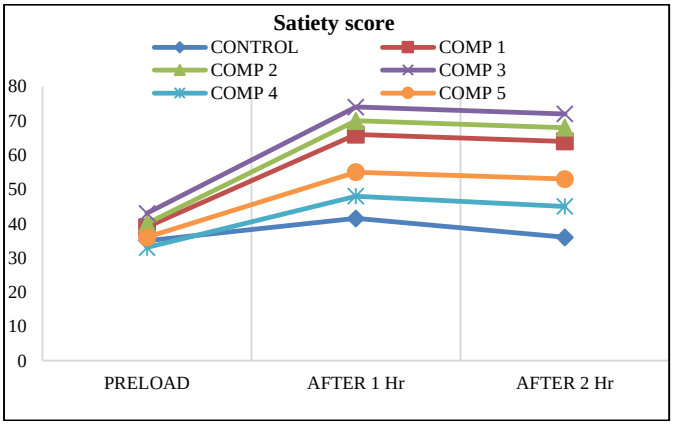

Fig 2

Conclusion

The results obtained in this study indicated that the banana peel can be used in the food industry for the purpose of value addition of fibre. As tuna fish contain sufficient amount of protein, it can be used as an alternative source for protein enrichment in food products. Banana Peel Flour (BPF) and Fish Protein Concentrate (FPC) are excellent contributors of protein and fiber. Using FPC, BPF and the base material (Maida), different compositions are developed. The best satietic composition among all the five is composition 3, with 30g and 7g of protein and fiber respectively. The satietic score of this composition was high with a score of 72 ± 4.582, two hour after the consumption of test food and ad libitum food consumed were minimum, having a value of 188.686 ± 5.139 Kcal.

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