**Formulation and Evaluation of Acacia-Based *Sev* Enriched with Banana Flour**

**Abstract**

This research investigates the preparation and evaluation of a healthy version of the Indian snack *sev* based on composite *Acacia nilotica* pods flour and raw banana pulp. Different combinations of the composite flour were prepared by substituting wheat flour at different percentages. Nutritional analysis indicated that the inclusion of *Acacia nilotica* appreciably enhanced protein (up to 11.86%), dietary fibre, ash, and crude fat content and reduced carbohydrates slightly. Of the tested formulation, Type-I (30% acacia:70% banana) and Type-II (50:50) were organoleptically acceptable, whereas Type-III (70:30) was less acceptable as it had a discernible bitter taste. Antioxidant capacity and mineral yield were augmented as the concentration of acacia flour was raised. Sensory attributes indicated that *sev* prepared from up to 50% composite acacia-banana flour was extremely acceptable. The findings lean towards the possible use of *Acacia nilotica* and banana flour as functional food ingredients for healthier snack foods using lesser-prioritised plant resources.

***Key words****:* Acacia nilotica, Nutritional composition, Banana flour, *Sev*

1. **Introduction**

Traditional foods have a distinct texture and taste, making them an important part of people's diets across countries. Snack foods make up a large portion of traditional foods. According to Webster's New Ninth Collegiate Dictionary (1985), the noun "snack" (first used in 1757) refers to a "light meal, foods eaten between regular meals, food suitable for snacking" and the verb snack means "to eat a snack." According to Kulkarni (1992), snacks made from locally accessible raw ingredients evolved as a way to break up monotony in diets. Traditional Indian cuisine consists of cereal, pulses, and vegetables, made both at home and at commercial facilities (Waghray and Gulla, 2010).

*Acacia nilotica* is also known as the Babul, Kikar, or Indian gum Arabic tree. It belongs to the Leguminosae-Mimosoideae family and can be found throughout India. It is a significant multipurpose tree, with almost every part used to treat an ailment. Because of their potential benefits for a number of chronic illnesses, the scientific community and consumers have shown a strong interest in bioactive compounds such as antioxidants (Revathi *et al.,*2017). Synthetic antioxidants are often utilised in the food processing industry to extend product shelf life while also promoting them as healthy meals. However, high doses of these synthetic antioxidants have been demonstrated to be toxic rather than beneficial to health. Some are known to cause cancer and other negative health effects. These effects can be avoided by replacing them with natural antioxidants found in Acacia nilotica. Almost all of its ingredients are used in pharmaceuticals and have been found to have numerous health benefits, including anti-inflammatory, anti-diabetic, antihypertensive, and in vitro anticancer properties (Saggu *et al.,*2015; Majumder *et al.,*2021). Overall, *Acacia nilotica* pods could be a useful functional component due to their nutritional value, processing functionality, and potential health advantages. However, acacia pods are bitter, rendering them unsuitable for value addition. To boost *Acacia nilotica's* market potential in the food industry, it is necessary to find a suitable vehicle that can provide a food matrix to mask the bitterness of acacia while also possessing product development attributes.

Mature banana pulp is abundant in iron, potassium, and vitamin A, but low in protein and fat (Adeniji *et al.*2006). Ripe banana flour is perfect for food preparations that require great solubility, sweetness, and energy density. content. Zhang *et al.* (2005) and Mohapatra *et al.* (2010) investigated and described the physical properties of fresh bananas and their components, including banana starch. They are wealthy. They are rich in vitamin B6, fibre, vitamin C, magnesium, and potassium. Bananas are high in vitamins and minerals, with each large serving providing 123 I.U. of vitamin A. According to Vasudha and Misra (2013), bananas are a healthful fruit that can improve the taste of food.

1. **Materials and Methods**

**2.1 Raw Materials Procurement**

Ingredients for meal preparation were obtained in bulk from the local market, including wheat flour, banana, vegetable oil, fat, sugar, yeast, salt, and other additions. *Acacia nilotica* pods were gathered from the Department of Forestry at CCS Haryana Agricultural University, Hisar.

* 1. **Processing of Raw Materials and Composite Flour Preparation**

The raw materials—raw bananas and Acacia seeds—were cleaned, peeled, sliced (for bananas), and dried under controlled conditions. Dried materials were then milled separately into fine flours and sieved. The composite flours were prepared by blending the two flours in specific ratios for subsequent analysis and product development.

***2.2.1 Acacia nilotica* Flour Preparation**

The *Acacia nilotica* pods collected were manually hand-sorted to eliminate foreign particles and unripe pods. They were washed with tap water and subsequently with distilled water to eliminate surface debris and microbial contamination. Upon draining, the pods were shade-dried under natural conditions for 7–10 days to preserve their bioactive constituents and color. After drying to a brittle state, pods were milled into fine powder with a high-speed laboratory hammer mill and then sifted through a 60-mesh sieve to achieve uniform Acacia flour, which was kept in silica gel packet-enclosed airtight containers to prevent moisture absorption.

**2.2.2 Raw Banana Flour Preparation**

Raw bananas were manually peeled and cut evenly (about 2 mm thickness) on a stainless-steel slicer. Slices were blanched in hot water at temperatures of 85–90°C for 10 minutes, which inactivates polyphenol oxidase enzymes, decreases microbial load, and maintains color. The blanched slices were quickly cooled in cold water to halt cooking and subsequently dried in a hot-air oven at 65°C for 6–8 hours until moisture content was lowered to <10%. Dried slices were powdered and sieved (60-mesh) to have raw banana flour. The flour was packed in moisture-proof pouches and stored at room temperature.

To create composite flour, individual Acacia and Banana flours were combined in the following proportions:
Type-I flour (30% acacia flour and 70% raw banana flour)

Type-II flour (50% acacia flour and 50% raw banana flour)

Type-II flour (70% Acacia flour and 30% Raw banana flour)

 Type-III flour with 70% Acacia flour was not acceptable organoleptically and was therefore not subjected to further analysis. Type I and Type II composite flours were stored in air tight plastic containers for further analysis.

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Plate 1: Composite Flours

**Control**

**T-I**

**T-II**

**T-III**

Plate 2: 30:7 Composite flour supplemented *sev*

***2.2.3 Sev* Formulation**

In order to assess the usability of composite flour in snack food, *sev*-type extruded sev were made with the following wheat flour-composite flour replacement ratios:

**Process:** A typical recipe consisted of wheat flour (or its mixture), Bengal gram flour, salt, spices (ajwain, turmeric, chili powder), and water. The mixture was kneaded to a semi-soft state to make the dough. The dough was processed through a *sev* press having a fine-holed plate, and extrudates were fried in refined vegetable oil at 170–180°C until golden brown. The fried foods were brought to room temperature and stored in food-grade polyethylene pouches for subsequent analysis.

Control: Wheat flour (100%)

Type-I: Composite flour: Wheat flour (20:80)

Type-II: Composite flour: Wheat flour (30:70)

Type-III: Composite flour: Wheat flour (40:60)

* 1. **Nutritional Analysis**

The composite flours were analyzed for the following proximate parameters: moisture content, crude protein, crude fat, ash content, crude fiber, and total carbohydrates by subjecting them to proximate analysis. The analyses were conducted in triplicate, and results were presented as percentage dry weight by employing standard methods detailed by the Association of Official Analytical Chemists (AOAC, 2016).

**2.3.1 Proximate Composition**

**2.3.1.1 Moisture**

Moisture content was analyzed according to the AOAC (2000) method. 5 g sample was dried in a hot air oven at 105°C for 6 hours, cooled over a desiccator, and weighed again. Moisture (%) was computed using loss in weight.

Moisture (%) ×100

**2.3.1.2 Protein**

Crude protein was quantitated by the Kjeldahl procedure (AOAC, 2000) with a KEL PLUS nitrogen analyzer. Digestion was done at 420°C using a K₂SO₄:CuSO₄ (5:1) catalyst and conc. H₂SO₄, distilled in 40% NaOH, and ammonia absorbed in 4% boric acid. Distillate was titrated against 0.1 N HCl, and nitrogen was times 6.25 to get crude protein.

% of Nitrogen =

Titrant value = Volume of N/10 HCl used for titration

 % Crude Protein = N × 6.25

**2.3.1.3 Fat**

Fat was quantified by solvent extraction (AOAC, 2000) in petroleum ether (60–80°C) in an Automatic SOCS Plus system. 5 g of dry matter was extracted at 90°C for 1 hour, and the solvent evaporated. The beaker was dried at constant weight at 60°C, and fat was gravimetrically calculated.

Where, W = Weight of sample (g) , W1 = Weight of empty beaker , W2 = Weight of beaker with fat

**2.3.1.4 Ash**

Ash content was determined by burning 5 g of sample in a muffle furnace at 550°C for 5–6 hours (AOAC, 2000). Weight of the residue was employed to calculate ash content.

**2.3.1.5 Crude Fibre**

Crude fibre was established by serial reflux of 1 g fat-free sample with 1.25% H₂SO₄ and 1.25% NaOH (AOAC, 2000). The residue was washed, filtered, ashed at 550°C, and dried at 100°C. The content of fibre was estimated by weight loss on ashing.

Crude fibre (%)

Where, W1 = Weight of sample (g) , W2 = Weight of insoluble matter (wt. of crucible + insoluble matter– wt. of crucible) , W3 = Weight of ash (wt. of crucible + wt. of ash – wt. of crucible)

**2.3.1.6 Carbohydrates**

The total carbohydrate was calculated by difference method.

Total carbohydrate (%) = 100 – (Crude protein % + Crude fiber % + Crude fat % + Total ash %)

**2.3.1.7 Dietary Fibre**

Total dietary fibre (TDF), expressed as soluble (SDF) and insoluble (IDF) fractions, was determined by the enzymatic-gravimetric technique (Furda, 1981). 1 g defatted sample was digested enzymically with HCl, EDTA, phosphate buffer, α-amylase, and protease. IDF was isolated by filtration and SDF was precipitated from the filtrate with ethanol after acidification. Both were ash and protein corrected, and TDF was determined as:

TDF= IDF+SDF

**2.4.Anti-Nutritional Factors**

The major anti-nutritional factor analyzed in the composite flours is phytic acid. The test was conducted in triplicate and expressed in mg/100 g of sample on a dry weight basis**.**

**2.4.1Phytic Acid**

Phytic acid was determined by the colorimetric procedure (Haug and Lantzsch, 1983). A sample of 0.5 g was shaken with 25 mL of 0.2 N HCl for 3 hours. The extract was treated with ferric ammonium sulfate, heated, centrifuged, and finally combined with bipyridine. Absorbance was measured at 519 nm, and phytic acid was calculated from a sodium phytate standard curve.

**2.4.2 Antioxidant Activity**

Methanolic extracts of dry samples were examined using the DPPH method in order to assess the antioxidant capacity. Absorbance was determined at 517 nm and activity measured using a standard calibration curve.

Per cent inhibition of activity = [(Ac-Ae)/Ac) x 100

(where, Ac absorbance of control; Ae absorbance of extract)

DPPH (mg TE/100g) = Dilution factor

* 1. **Sugar and Starch Content**

Sugar and starch contents were analyzed to determine the concentration of simple and complex carbohydrates in the composite flour, which influence its nutritional value, taste, and functional properties

**2.5.1Total Soluble Sugars**

Estimated by the anthrone method (Yemm & Willis, 1954). Sugar extract responded to anthrone reagent, heat treatment, and absorbance read at 620 nm. Quantified with a glucose standard.

**2.5.2 Reducing Sugars**

Determinations by Somogyi-Nelson procedure. Sample extract was mixed with copper reagents, boiled, cooled, with arsenomolybdate treated and read absorbance at 520 nm.

**2.5.3 Starch Content**

Starch was precipitated with 52% perchloric acid (Clegg, 1956) and determined by anthrone procedure. Glucose value was being multiplied by 0.9 to find starch content.

Starch = Glucose × 0.9

* 1. **Mineral Analysis**

Mineral analysis was carried out to determine the levels of essential macro- and micronutrients present in the composite flour samples, which contribute to the overall nutritional quality.

**2.6.1 Total Minerals**

Samples were digested using a diacid mixture (HNO₃:HClO₄, 5:1) and was heated until it was clear. Calcium, iron, zinc, magnesium, and potassium were determined after filtering by Atomic Absorption Spectrophotometry (Lindsey & Norwell, 1969).

Minerals (mg/100g)=

**2.6.2 Total Phosphorus**

Estimated colorimetrically (Chen *et al.,*1956). The mineral extract was reacted with reagent C, incubated at 37°C for 90 min, and absorbance read at 720 nm.

**2.7. Sensory Evaluation**

Value-added food items were scored for appearance, taste, texture, colour, and general acceptability on a 9-point Hedonic scale. The most accepted samples were kept in polythene bags at room temperature for a period of one month to note the shelf life.

1. **Results**

**3.1 Nutritional Composition**

The nutritional composition of the composite flour samples was evaluated to determine their proximate contents, including moisture, protein, fat, ash, fibre, and carbohydrates, which are essential indicators of overall dietary value

**3.1.1 Proximate composition**

**3.1.1.1 Moisture**

Moisture content of both composite flour samples varied from 3.93 to 4.56, per cent, respectively (Table 1). Maximum (4.56 %) in Type-II composite flour and minimum (3.93 %) in Type 1 composite flour samples. Moisture content of composite flour blends differed significantly (p≤0.05).

**3.1.1.2 Crude protein**

Raw banana flour contained 2.86% crude protein, while that of Acacia flour was significantly higher at 12.66% (Table 1). Composite flours registered a proportionate rise in protein level with the degree of incorporation of Acacia flour from 9.36% in Type I to 11.86% in Type II. This increase in protein level is statistically significant (p ≤ 0.05) and indicates that Acacia flour is a good protein fortifier in composite flour blends.

**3.1.1.3 Crude fat**

Crude fat content of raw banana flour was 1.60%, and, in the case of Acacia flour, it was 3.43%. Composite flours had much (p ≤ 0.05) higher fat content with the increase in Acacia flour from 2.40% in Type I to 2.73% in Type II. It shows that Acacia flour is responsible for lipid content of composite mixtures (Table 1).

**3.1.1.4 Ash**

Ash content, a reflection of total mineral content, was 3.33% for raw banana flour and 4.13% for Acacia flour. Composite flours were reported to exhibit a moderate but statistically significant (p ≤ 0.05) increase in ash content with an increase in the proportion of Acacia flour, from 3.66% in Type I to 3.73% in Type II. This is a reflection of an increase in the mineral content of composite flours with the inclusion of Acacia flour (Table 1).

**3.1.1.5 Crude fibre**

Crude fibre content was much higher in Acacia flour (12.66%) than raw banana flour (1.73%). Composite flours had a significant (p ≤ 0.05) rise in crude fibre content with the addition of more Acacia flour, varying from 4.96% in Type I to 5.50% in Type II. Rise in dietary fibre content is advantageous in the production of high-fibre food products (Table 1).

**3.1.1.6 Carbohydrates**

Raw banana flour had the highest concentration of carbohydrates at 90.48%, whereas Acacia flour had a relatively lower concentration of 67.12%. In the composite flour blends, the concentration of carbohydrates considerably reduced (p ≤ 0.05) with the rise in the concentration of Acacia flour, from 79.62% in Type I to 76.18% in Type II (Table 1).

**Table 1:** Proximate composition of composite flour (% on dry matter basis)

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | RBF (100%) | AF (100%) | Composite flours |
| T-1 (30:70) | T-II (50:50) | CD (p≤0.05) |
| Moisture | 5.63±0.12 | 4.13±0.03 | 3.93±0.03  | 4.56±0.03 | 0.18 |
| Crude Protein | 2.86 ±0.03 | 12.95±0.08  | 9.36±0.06  | 11.86±0.04  | 0.85 |
| Crude Fat | 1.60±0.15 | 3.43±0.06 | 2.40±0.11 | 2.73±0.08 | 0.22 |
| Ash | 3.33±0.08 | 4.13±0.03 | 3.66±0.12 | 3.73±0.06 | 0.20 |
| Crude Fibre | 1.73±0.06 | 12.66±0.06 | 4.96±0.06 | 5.50±0.15 | 0.26 |
| Carbohydrate (by difference) | 90.48±0.09 | 67.12±0.05 | 79.62±0.08 | 76.18±0.06 | 0.23 |

**3.1.2 Dietary fibre**

The results on dietary fiber content of composite flour blends containing raw banana flour and Acacia flour at varied amounts are provided in Table 2. Raw banana flour contains 49.43 g of total, 8.80 g of soluble, and 40.63 g of insoluble dietary fibre per 100g. Acacia flour has 22.79 g of total, 10.26 g of soluble, and 12.53 g of insoluble dietary fibre per 100g. Type-I had considerably greater (p≤0.05) total, soluble, and insoluble dietary fibre (43.60, 15.80, and 27.80 g/100g), while Type-II had significantly lower (p≤0.05) total, soluble, and insoluble fibre (40.69, 14.89, and 25.80 g/100g, respectively).

**Table 2:** Dietary fiber content of composite flours (g/100g, on dry matter basis)

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | RBF (100%) | AF (100%) | Composite flours |
| T-1 (30:70) | T-II (50:50) | CD (p≤0.05) |
| Total Dietary fiber | 49.43±0.14 | 22.79±0.08 | 43.60±0.05  | 40.69±0.57  | 0.37 |
| Soluble Dietary fiber | 8.80 ±0.05  | 10.26±0.26  | 14.89±0.07  | 15.80±0.09  | 0.34  |
| Insoluble Dietary fiber | 40.63±0.12  | 12.53±0.08  | 27.80±0.05  | 25.80±0.05  | 0.34 |

**3.2 Anti-nutritional factors**

**3.2.1 Phytic acid**

Phytic acid content of both types of composite flour samples varied from 18.33 to 28.50 mg/100g, respectively. Type-I composite flour had lower (18.33 mg/100g) phytic acid content whereas, Type-II composite flour had higher (28.50 mg/100g) content. Whereas, phytic acid content for control sample i.e raw banana flour and Acacia flour was noticed as 4.70 and 52.80 mg/100g, respectively. Significant (p≤0.05) differences were also observed among both the composite flours in terms of their phytic acid content (Table 3).

**Table 3:** Anti-nutritional factors (mg/100g) of composite flours (on dry matter basis)

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | RBF (100%) | AF (100%) | Composite flours |
| T-1 (30:70) | T-II (50:50) | CD (p≤0.05) |
| Phytic acid  | 4.70±0.05 | 52.80±0.34 | 18.33±0.21 | 28.50±0.45 | 1.06 |

**3.3 Anti-oxidant activity**

Antioxidant activity was significantly increased (p≤0.05) with the incorporation of Acacia flour. Raw banana flour contained 12.23% activity, whereas Acacia flour contained 59.60%. Composite flours exhibited greater antioxidant activity: Type I (30% AF:70% RBF) at 27.05% and Type II (50% AF:50% RBF) at 34.06%. This is because of the greater antioxidant capacity of Acacia flour (Table 4).

**Table 4:** Anti-oxidant activity (%) of composite flours (on dry matter basis)

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | RBF (100%) | AF (100%) | Composite flours |
| T-1 (30:70) | T-II (50:50) | CD (p≤0.05) |
| DPPH  | 12.23±0.03 | 59.60±0.06 | 27.05±0.45 | 34.06±0.07 | 1.52 |

**3.4 Sugar and Strach content**

The data presented in table 5 showed that total soluble sugars were 4.73 and 2.13 g/100g in raw banana flour and Acacia flour, respectively. Raw banana flour was found to contain 1.63 g/100g reducing sugars whereas Acacia flour had 0.70 g/100g. Raw banana flour contained 68.36 g/100g starch while Acacia flour had 11.46 g/100g.

The total soluble sugar content of type I and type II flours was 3.80 and 3.26 g/100g, respectively. The contents of reducing sugars for composite flours were 1.63 and 1.40 g/100g for type I and type II, respectively. Type-I flour contained 45.76 g/100g starch while type-II flour had 44.33 g/100g. The data depicted those total soluble sugars, reducing sugars and starch content were decreased with increased composition of Acacia flour in raw banana flour.

**Table 5:** Total soluble sugars, reducing sugars and starch of composite flour (g/100g, on dry weight basis)

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | RBF (100%) | AF (100%) | Composite flours |
| T-1 (30:70) | T-II (50:50) | CD (p≤0.05) |
| Total Soluble sugar | 4.73±0.03 | 2.13±0.03 | 3.80±0.05 | 3.26±0.08 | 0.15 |
| Reducing Sugar | 1.63 ±0.08 | 0.70±0.05 | 1.63±0.08 | 1.40±0.11 | 0.17 |
| Starch | 68.36±0.06 | 11.46±0.06 | 45.76±0.08 | 44.33±0.08 08 | 0.31  |

**3.5 Total mineral content**

The mineral composition of composite flours differed with the proportion of Acacia flour (4.6). Type II (50% AF:50% RBF) had higher amounts of calcium (132.23 mg/100 g), iron (62.91 mg/100 g), and zinc (72.29 mg/100 g) than Type I (30% AF:70% RBF), which had 112.22 mg/100 g calcium, 44.32 mg/100 g iron, and 44.32 mg/100 g zinc. The rise in mineral content with increased Acacia flour addition was statistically significant (p ≤ 0.05) (Table 6).

**Table 6:** Total mineral contents of composite flour (mg/100g, on dry weight basis)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Composite flours  | Calcium  | Iron  | Zinc  | Potassium  | Magnesium  | Phosphorus  |
| AF | 234.18±0.01 | 79.60 ±0.05  | 150.64±0.03  | 962.15±0.14  | 109.62±0.05  | 642.83±0.68  |
| RBF | 6.68±0.09 | 2.47±0.03 | 1.85 ±0.02  | 252.14±0.02  | 98.44 ±0.18  | 122.75±0.00 |
| T-I | 112.22±0.05  | 44.32±0.02  | 44.32±0.07  | 423.51±0.33  | 104.62±0.04  | 271.83±10.66 |
| T-II | 132.23±0.00  | 62.91±0.27  | 72.29±0.07  | 508.45±0.32  | 106.67±0.10  | 390.42±0.86  |
| CD (p≤0.05) | 0.14 | 0.48 | 0.20 | 0.70 | 0.32 | 18.75 |

**3.6 Sensory Attributes**

Mean scores of organoleptic characteristics (colour, appearance, aroma, texture, taste and overall acceptability) of developed value-added food product *sev* presented in the Table 7,

**3.6.1 Taste**

The control Bengal gram *sev* had the best colour score of 8.80, showing they were 'liked very much'. The colour scores dropped as the level of Acacia flour was high in the composite flours: Type I had score 7.80, Type II 6.70, and Type III 5.70. The panel scored *sev* prepared using Type III (5.70) composite flour as 'neither liked nor disliked'.

**3.6.2 Appearance**

Appearance score for control *sev* was 8.80 ('liked very much'). Composite flour *sev* registered a decline in appearance scores with rising Acacia flour content: from 7.80 to 5.80. Type III *sev* belonged to the 'neither liked nor disliked' category.

**3.6.3 Aroma**

Control sev were 8.70 in aroma score. The aroma scores of composite flour sev reduced with the incorporation of higher percentages of Acacia flour: Type I was 8.10, Type II 6.70, and Type III 5.70. Type III *sev* were 'neither liked nor disliked' for aroma.

**3.6.4 Texture**

Texture of control sev was 8.90. Texture values of composite flour sev reduced with increasing percentage of Acacia flour: Type I was 7.90, Type II 6.70, and Type III 5.60. Type III sev were in 'neither liked nor disliked' category in terms of texture.

**3.6.5 Taste**

Mean scores of taste of Type-I and Type-II composite flour made *sev* were found in the range of 7.80 to 6.50 i.e. ‘liked moderately’ to ‘liked slightly’. Whereas mean scores of taste of Type-III *sev* was found 5.40 in the category of ‘neither liked nor disliked’ by the panelists.

**3.6.6 Overall Acceptability**

Overall acceptability scores of *sev* made from bengal gram flour had 8.80, whereas three types of composite flour made *sev* i.e. Type-I and Type-II were ranged 7.90 and 6.80 respectively fell in the category of ‘liked moderately’ to ‘liked slightly’.

**Table 7**: Mean scores of organoleptic characteristics of value-added sev

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Composite flours  | Colour | Appearance | Aroma | Texture | Taste | Overall Acceptability  |
| Control (BGF 100%) | 8.80±0.13 | 8.80±0.13 | 8.70±0.15 | 8.90±0.10 | 8.80±0.13 | 8.80±0.03 |
| T-I (CF:BGF::20:80) | 7.80±0.20 | 7.80±0.13 | 8.10±0.10 | 8.00±0.00 | 7.80±0.20 | 7.90±0.06 |
| T-II (CF:BGF::30:70) | 6.80±0.20 | 7.00±0.21 | 7.10±0.23 | 6.60±0.16 | 6.50±0.22 | 6.80±0.11 |
| T-III (CF:BGF::40:60) | 5.70±0.21 | 5.80±0.20 | 5.60±0.26 | 5.60±0.26 | 5.40±0.26 | 5.62±0.06 |
| CD (p≤0.05) | 0.52 | 0.42 | 0.50 | 0.41 | 0.41 | 0.21 |

**3.7 Nutritional evaluation of most acceptable value-added sev**

**3.7.1 Proximate composition**

It was found that *sev* prepared with type I composite flour was most acceptable. The nutritional analysis showed that total carbohydrates (56.27) content of control *sev* were significantly **(**p≤0.05) higher than type I *sev* (51.69 g/100g, respectively) whereas moisture, crude protein, fat, ash and crude fibre content were significantly **(**p≤0.05) higher in type I *sev* (2.56, 18.64, 21.88, 2.85 and 4.94 g/100g, respectively) as compared to control *sev* (2.39,16.32, 22.18, 2.62 and 2.61 g/100g, respectively).(Table 8).

**3.7.2 Dietary fibre**

Total dietary fibre and soluble dietary fibre content was significantly **(**p≤0.05) higher in type-I *sev* (12.65 and 3.95 g/100g) as compared to control *sev* (11.72 and 2.19 g/100g, respectively). Insoluble dietary fibre content of control *sev* was 9.53 which found to be higher as compared to type-I *sev* 8.70 g/100g, respectively.(Table 9).

**Table 8:** Proximate composition of sev (g/100 g, on dry weight basis)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Products | Moisture | Crude protein | Fat | Ash  | Crude Fibre | Total Carbohydrates |
| Control W.F (100) | 2.39±0.01 | 16.32±0.01 | 22.18±0.01 | 2.62±0.00 | 2.61±0.00 | 56.27±0.01 |
| T-I | 2.56±0.00 | 18.64±0.30 | 21.88±0.01 | 2.85±0.02 | 4.94±0.02 | 51.69±0.03 |
| ‘t’ value | 20.13\* | 7.58\* | 17.19\* | 10.59\* | 113.39\* | 126.04\* |

**Table 9:** Total dietary Fiber, Soluble dietary Fiber and Insoluble dietary Fiber content of sev (g/100g, on dry weight basis)

|  |  |  |  |
| --- | --- | --- | --- |
| Products | Total Dietary Fiber  | Soluble Dietary Fiber  | Insoluble Dietary Fiber  |
| Control W.F (100) | 11.72±0.05 | 2.19±0.05 | 9.53±0.05 |
| T-I | 12.65±0.08 | 3.95±0.03 | 8.70±0.03 |
| ‘t’ value | 32.88\* | 2.50\* | 50.01\* |

**3.7.3 Antinutritional factor**

Control *sev* contained 160.23 mg/100g phytic acid, which was found to be increased significantly **(**p≤0.05) in type-I *sev* 195.86 mg/100g, respectively.

(Table 10)

**Table 10:** Anti-nutritional activity of sev (mg/100g)

|  |  |
| --- | --- |
| Products | Anti-nutritional Factor (Phytic acid) (mg/100g) |
| Control W.F (100) | 160.23±0.13 |
| T-I | 195.86±0.37 |
| ‘t’ value | 89.39\* |

**3.7.4Antioxidant activity**

The findings of the study revealed that antioxidant activity (DPPH) of type-I *sev* (40.66 mg TE/100g) were higher as compared to control *sev* (23.40 mg TE/100g, respectively).(Table 11).

**Table 11:** Antioxidant activity of sev (mg TE/100g)

|  |  |
| --- | --- |
| Products | Antioxidant activity DPPH (mg TE/100g) |
| Control W.F (100) | 23.40±0.25 |
| T-I | 40.66±0.03 |
| ‘t’ value | 68.01\* |

**3.7.5 Sugar and Strach content**

It was found that total soluble sugars and reducing sugar in type I *sev* (13.36 and 5.23 g/100g, respectively) were significantly **(**p≤0.05) higher than that of control *sev* (12.20 and 4.16 g/100g, respectively). The starch content was significantly **(**p≤0.05) higher in control *sev* (46.30 g/100g) as compared to type I *sev* (34.56 g/100g). (Table 12).

**Table 12:** Total soluble sugars, reducing sugars and starch content of sev (g/100g, on dry weight basis)

|  |  |  |  |
| --- | --- | --- | --- |
| Products | Total Soluble Sugar  | Reducing Sugars | Starch |
| Control W.F (100) | 12.20±0.05 | 4.16±0.03 | 46.30±0.10 |
| T-I | 13.36±0.16 | 5.23±0.08 | 34.56±0.12 |
| ‘t’ value | 4.72\* | 11.31\* | 12.80\* |

**3.8 Total mineral content**

The results revealed that calcium content was found significantly **(**p≤0.05) higher in type I *sev* (79.86 mg/100g) as compared to control *sev* (56.60 mg/100g) while potassium, magnesium, zinc, phosphorus and iron content of control *sev* i.e. 295.83, 62.66, 2.76, 245.63 and 3.86 mg/100g, respectively were significantly **(**p≤0.05) lower than type I *sev* i.e. 390.40, 78.40, 5.80, 260.73, and 6.13 mg/100g, respectively. (Table 13).

**Table 13:** Total mineral content of sev (mg/100g, on dry weight basis)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Products | Calcium  |  Iron  | Zinc  | Potassium  | Magnesium  | Phosphorus  |
| Control W.F (100) | 56.60±0.25 | 3.86±0.01 | 2.76±0.08 | 295.83±3.18 | 62.66±0.18 | 245.63±1.48 |
| T-I | 79.86±0.03 | 6.13±0.40 | 5.80±0.10 | 390.40±17.54 | 78.40±0.05 | 260.73±4.18 |
| ‘t’ value | 91.65\* | 5.58\* | 22.75\* | 5.30\* | 80.94\* | 3.40\* |

**4. Discussion**

**4.1 Nutritional composition of composite flour**

Raw banana flour's (5.63%) and Acacia flour's (4.13%) moisture content greatly (p≤0.05) increased in Type-I and Type-II composite flours to 3.93% to 4.56%. Inclusion of Acacia flour raised the crude protein and crude fibre content in the composite mix because Acacia flour was made up of 12.66% protein and fibre, supported by Carter (1988) and Barman & Rai (2004). Increased ash content in Acacia suggests higher mineral content, aligning with Fagg's (2001) and Abdalla et al. (2013) observations.

Raw banana flour contained elevated total (49.43 g/100g), soluble (8.80 g/100g), and insoluble fibre (40.63 g/100g) fibre values similar to those documented by Menezes *et al.* (2011) and Juarez-Garcia *et al.* (2006). In Type-I *sev*, adding Acacia increased total, soluble, and insoluble fibre largely above levels documented by Ajayi *et al.* (2017).

Phytic acid levels also varied from 4.70 mg/100g (banana flour) and 52.80 mg/100g (Acacia flour) to 18.33–28.50 mg/100g in composite flours and determined *sev*'s phytate levels. Siddhuraju *et al.* (1996) previously found 9.2 g/kg in A. nilotica. Though phytic acid diminishes bioavailability of minerals, its antioxidant, anti-cancer activity, lowering of cholesterol and blood glucose levels are well established (Onomi *et al.,*2004; Turner *et al.,*2002).

Antioxidant activity was enhanced upon Acacia addition into *sev* formulations because of its high polyphenolic content. Raw banana flour revealed 12.23%, whereas Acacia revealed 59.60%, in agreement with Abdel-Farid *et al.* (2014).

The starch and sugar composition of *sev* varied with composition: raw banana flour contained 4.73 g/100g total soluble sugars, 1.63 g/100g reducing sugars, and 68.36 g/100g starch, while Acacia flour contained 2.13 g, 0.70 g, and 11.46 g/100g, respectively. Higher Acacia flour resulted in the reduction of total sugars and starch in *sev*, as consistent with Menezes *et al.* (2011) and Suntharalingam & Ravindran (1993).

There was a considerable (p≤0.05) increase in mineral levels (e.g., Zn, Cr) in *sev* because of Acacia flour. Ndamitso *et al.* (2017) and Nandal & Bhardwaj (2014) indicated that *Acacia nilotica* is richer in key minerals than traditional legumes.

**4.2 Sensory evaluation of developed products**

Overall acceptability scores for control goods' colour, look, texture, scent, and taste were in the 'loved very lot' category. The overall acceptance scores of composite flour products ranged from "neither liked and nor disliked" to "liked very much." *Sev* were most palatable at 20% composite flour content in wheat flour. In the current study, *sev* were assessed as very appreciated by panellists up to 20% composite flour content. Increasing the amount of Acacia flour in the raw banana flour mix resulted in a substantial decrease in overall acceptability scores of *sev*. A number of other authors have reported similar findings.

**4.3 Nutritional evaluation of developed products**

The proximate analysis showed that crude protein, fat, ash, and crude fibre contents of Type-I *sev* were significantly (p≤0.05) greater than those of the control, while total carbohydrate content was significantly less, consistent with previous results by Adeola and Ohizua (2018).

Total and soluble dietary fibre content was considerably (p≤0.05) increased in Type-I *sev*, whereas the insoluble fibre content was decreased (8.70 g/100g) as compared to control *sev* (9.53 g/100g). Results were the same as recorded by Stamatovska *et al.* (2017) in Acacia gum and by Agama-Acevedo *et al.* (2012) in unripe banana flour-supplemented cookies.

Type-I *sev* (195.86 mg/100g) contained significantly more phytic acid than control (160.23 mg/100g), which would probably be because of Acacia inclusion. Reduced glycemic response and cholesterol-lowering effects of phytate have been reported by Yoon *et al.* (1983) and Jariwalla *et al.* (1990). Phytate has a protective action against kidney stone (Grases *et al.*2000).

Antioxidant activity was highly increased in Type-I *sev* (40.66 mg TE/100g) as a result of Acacia pod flour, supported by Abdel-Farid *et al.* (2014). The lowest antioxidant activity was found in control *sev*. These results coincide with findings that have emphasized food fortification with natural antioxidants as beneficial (Sridevi *et al.*2010; Vagi *et al.*2005).

Type-I *sev* also had much higher total soluble sugars (13.36 g/100g) and reducing sugars (5.23 g/100g) compared to the control, although its starch level was reduced—most probably indicating the effect of composite flour. Pareek and Choudhary (2013) have also shown similar trends in sugar content for Acacia flour.

Mineral analysis revealed considerably (p≤0.05) greater concentration of calcium, potassium, magnesium, zinc, phosphorus, and iron in Type-I *sev*. Type-I *sev*, though with more antinutrients, also retained better minerals.

**5. Conclusion.**

This study may indicate that Acacia and banana composite flour are suitable for the production of *sev*. *Sev* can contain up to 20% acacia and banana composite flour. The produced composite flour was high in protein, fibre, calcium, and iron, with potential antioxidant activity (DPPH). Value-added *sev* made with *Acacia nilotica* flour were both organoleptically pleasing and nutritionally helpful. The creation and application of functional foods with medicinal properties will not only improve the nutritional status of the general population, but will also aid those suffering from degenerative conditions. Acacia-fortified food products could be studied in the future to maintain vital health while also treating protein-energy malnutrition and vitamin deficiency.

**6 References**

Abdel-Farid, I. B., Sheded, M. G., & Mohamed, E. A. (2014). Metabolomic profiling and antioxidant activity of some Acacia species. Saudi Journal of Biological Sciences, 21(5), 400-408.

Adeniji, T. A., Sanni, L. O., Barimalaa, I. S., & Hart, A. D. (2006). Determination of micronutrients and colour variability among new plantain and banana hybrids flours. World Journal. Chemistry, 1(1), 23-27.

Adeola, A.A. and Ohizua, E.R. (2018). Physical, chemical, and sensory properties of sev prepared from flour blends of unripe cooking banana, pigeon pea, and sweet potato. Food Science Nutrition, 6: 532–540.

Agama-Acevedo, E., Islas-Hernandez, J.J., Pacheco-Vargas, G., Osorio-Diaz, P. and Bello-Perez, L.A. (2012). Starch digestibility and glycine index of cookie partially substituted with unripe banana flour. LWT- Food Science and Technology, 46: 177-182.

AOAC. (2000) Official Methods of Analysis. 16th Ed. Association of Official Analytical chemists. Arlyngton, Virginia, USA.

Barman, K., & Rai, S. N. (2004). In sacco degradability of few agro-industrial byproducts. Indian Journal of Animal Nutrition, 21(1), 26-29.

Carter, J., & Cowan, D. C. (1988). Phenology of *Acacia nilotica* subsp. indica (Berth.) Brenan. In Proceedings 5th Biennial Conference, Australia Ranelands Society, Longreach, Queenslan (pp. 9-12).

Clegg, K.M. (1956) The application of anthrone reagent to the estimation of starches in cereals. Journal of Agricultural and Food Chemistry, 7, 40-44.

Fagg C (2001) Acacia nilotica: Pioneer for dry lands. In: Agroforestry species and technologies. Roshetko, J.M (Ed.), Winrock International, Arizona, USA. Pp. 23-24.

Grases F, March JG, Prieto RM, Simonet BM, CostaBauzá A, García-Raja A. (2000)Urinary phytate in calcium oxalatestones formers and healthy people. Scandinavian journal of urology and nephrology, 34(3), 162-164.

Haug, W. & Lantzsch, H.J. (1983) Sensitive method for the rapid determination of phytate in cereals and cereal products. Journal of Science of Food and Agriculture, 34, 1423-1426.

Jariwalla, R. J., Sabin, R., Lawson, S., & Herman, Z. S. (1990). Lowering of serum cholesterol and triglycerides and modulation of divalent cations by dietary phytate. Journal of Applied Nutrition, 42(1), 18-28.

Kulkarni, A. P. (1992). Food quality control and processing. Eating on the run. *Food Laboratory News*, *8*(2), 10-13.

Lindsey, W.L. & Norwell, M.A. (1969) A new DPTA-TEA soil test for zinc and iron. Agronomy Abstract, 61, 84-89.

Mohapatra, D., Mishra, S., & Sutar, N. (2010). Banana and its by-product utilisation: an overview.

Nandal, U., & Bhardwaj, R. L. (2014). The role of underutilized fruits in nutritional and economic security of tribals: a review. Critical reviews in food science and nutrition, 54(7), 880-890.

Ndamitso, M.M., Mustapha, S., Etsuyankpa, M.B., Ajai, A.I. and Mathew, J.T. (2017). Evaluation of chemical composition of *Acacia nilotica* seeds. FUW Trends in Science & Technology Journal, 2(2): 927-931.

Onomi, S., Okazaki, Y., & Katayama, T. (2004). Effect of dietary level of phytic acid on hepatic and serum lipid status in rats fed a high-sucrose diet. Bioscience, biotechnology, and biochemistry, 68(6), 1379-1381.

Pareek, P. and Choudhry, M. (2013). Management of type 2 Diabetics by Indian Gum Arabic (Acacia nilotica) Pods Powder. International Journal of Food and Nutritional Science; 2(2): 77-83.

Sadiq, M. B., Hanpithakpong, W., Tarning, J., and Anal, A. K. (2015). Screening of phytochemicals and in vitro evaluation of antibacterial and antioxidant activities of leaves, pods and bark extracts of *Acacia nilotica* (L.) Del. Industrial crops and products, 77: 873-882.

Siddhuraju, P., Vijaykumari, K. and Janardhanan, K. (1996). Chemical composition and nutritional evaluation of an underexploited legume, *Acacia nilotica* (L.) Del. Food Chemistry, 57(3): 385 391.

Somogyi, N. (1945) A new reagent for the determination of sugar. Journal of Biological Chemistry, 160, 160-161.

Sridevi, N., Yenagi, B., Basavaraj, R. R. and Basarkar, P. W. 2010. Studies on antioxidants content of cooked and enriched foods of North Karnataka. Journal of Dairying Foods & Home Sciences, 29 (3): 204-209

Stamatovska, V., Nakov, G., Kalevska, T., Uzunoska, Z. and Saveski, A. (2017). Characteristics of sev with Acacia gum. 12th Symposium with international participation “Novel Technologies and Economic Development”, Faculty of Technology, Leskovac, Republic of Srbija.

Vagi, E., Rapavi, E., Hadolin, M., Vasarhelyine Peredi, K., Balazs, A., Blazovics, A., & Simandi, B. (2005). Phenolic and triterpenoid antioxidants from Origanum majorana L. herb and extracts obtained with different solvents. Journal of agricultural and food chemistry, 53(1), 17-21.

Vasudha, S., & Mishra, H. N. (2013). Non-dairy probiotic beverages. International Food Research Journal, 20(1).

Waghray, K., & Gulla, S. (2010). Butylated hydroxyanisole (BHA) to maximize the oxidative stability of snacks: A case study with *sev* and boondi. *Journal of Human Ecology*, *32*(2), 97-99.

Yemm, E.W. & Wills, A.J. (1954) The estimation of carbohydrates in plant extracts by anthrone. Journal of Biochemistry, 57(3), 508-514.

Yoon, J. H., Thompson, L. U., & Jenkins, D. J. (1983). The effect of phytic acid on in vitro rate of starch digestibility and blood glucose response. The American journal of clinical nutrition, 38(6), 835-842.

Zhang, P., Whistler, R. L., BeMiller, J. N., & Hamaker, B. R. (2005). Banana starch: production, physicochemical properties, and digestibility—a review. Carbohydrate polymers, 59(4), 443 458.