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# Nutritional, Physicochemical, Phytochemical, Antioxidant, and Shelf life analysis of Karpooravalli Banana pulp and peel prepared using Cabinet Drying

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**Abstract**

Bananas, which originated in India around 600 BC, are nutrient-dense tropical fruits. Karpooravalli bananas are especially nutritious, containing carbohydrates, amino acids, vitamins, and minerals. Moreover, banana peels, often regarded as waste, are rich in antioxidants and polyphenols. Unripe banana pulp and peels can be sliced approximately 2 mm thick, dipped in a 0.5% citric acid solution for 10 minutes, and then dried using a cabinet dryer. The cabinet-dried composite karpooravalli banana powder contains various nutrients moisture (4.47%), protein (7.56 g), fat (1.04 g), crude fiber (2.48 g), carbohydrates (78.85 g), energy (364.8kcal), calcium (80.6 mg), phosphorus (0.41 mg), potassium (64.3 mg), iron (0.0070 mg), and vitamin C (6.02mg). This powder is safe for consumption under hygienic conditions, and it requires proper handling. The physicochemical and functional properties of the powder include pH, total soluble solids, titratable acidity, bulk density, water-holding capacity, and oil-holding capacity. Phytochemical analysis has shown that the extracts contain bioactive compounds such as flavonoids, terpenoids, tannins, alkaloids, and saponins. The total phenolic content of the cabinet-dried composite karpooravalli banana powder extract was measured at 8.5, 12.4, and 15.6 mg/ml. Additionally, the antioxidant

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activity of the extracts was highest in the aqueous extract at 120 µg/ml, followed by the methanol extract at 112 µg/ml. Lower IC50 values indicate a higher potential for these extracts to scavenge free radicals.

**Key words :** Karpooravalli banana, Cabinet drying Nutrient analysis, Shelf life, phytochemical and Antioxidant activity.

The banana is a widely eaten fruit and a substantial herbaceous plant belonging to the genus Musa, which is part of the Musaceae family. This fruit is mainly grown in tropical and subtropical areas across the globe. Bananas are among the earliest cultivated crops, with records of their cultivation tracing back to approximately 600 BC in India[29]. India remains one of the largest global banana producers, contributing significantly to the global banana market. According to FAO data for 2023, India leads banana production, primarily serving its domestic market rather than focusing on exports. This contrasts with major exporters, such as Ecuador and Guatemala[9]. India's production is driven by favorable climatic conditions and is supported by a variety of banana types suited to both consumption and processing needs. Bananas rank as the fifth most traded agricultural product globally, following coffee, cereals, sugar, and cacao, and are an important fruit crop, trailing only behind citrus fruits, grapes, and apples. The banana is a nutrient-dense fruit and serves as a key source of numerous macronutrients, micronutrients, and phytonutrients[5]. Bananas have significant nutritional benefits and contain higher levels of flavonoids, dietary fiber, and resistant starch when they are unripe compared to when they are fully ripe[32]. Carbohydrates are the main constituents of unripe fruits, primarily composed of starch and non-starch polysaccharides (dietary fiber)[8,10]. Dietary fiber is crucial in preventing and managing obesity, atherosclerosis, heart diseases, colorectal cancer, and diabetes[24,31]. A significant feature of resistant starch is its inability to be digested within a two-hour period in the gut, and it encourages the growth of probiotics in the large intestine, potentially having a beneficial indirect effect on colorectal cancer[1].

This fruit is popular because it is economical and packed with nutrients. Often, the peel or pulp of bananas is viewed as a waste due to environmental contaminants. Hence, it is recommended to investigate the possible applications of banana peels in food products, as they are abundant in antioxidants and polyphenols. The worldwide production of bananas is expected to hit 72.5 million metric tons, with India accounting for 21.8 million metric tons. Notably, banana peels contain a higher concentration of phytochemical compounds than the edible part of the fruit. Furthermore, banana peels have antifungal and antibiotic characteristics that can offer health advantages to humans[2]. Bananas rank as the second most significant fruit crop in India and they are available throughout the year, affordable, diverse in types, flavorful, and possess various nutritional and medicinal advantages. This popularity makes them a preferred fruit among all socioeconomic classes[23].

Karpooravalli banana *(Musa balbisiana)* is a valuable fruit that provides considerable nutritional advantages. It is rich in carbohydrates, amino acids, vital vitamins (such as vitamin C and B6), as well as minerals like phosphorus, potassium, zinc, calcium, and manganese. Due to its remarkable nutrient content, it serves as an excellent choice for a healthy diet, especially beneficial for children, and supports healthy weight gain in babies[7,14]. Additionally, this fruit has antioxidant characteristics and potential medicinal benefits. It functions as an antimicrobial agent, shows potential as an antidiabetic agent, and offers a variety of health benefits[28]. Bananas also serve as a good source of starches that can be transformed into resistant forms, which help to slow down digestion and reduce the glycemic index[6]. Due to their high perishability, postharvest losses of bananas are primarily caused by mechanical, microbiological, and physiological factors. Mechanical injuries and abrasions can lead to dark sunken spots on the skin. Therefore, handlers should exercise caution when handpicking bananas to prevent damage to the skin[34]. Since bananas spoil quickly, drying them during processing is necessary to extend their shelf life. Banana powder, produced through drying, has high storability and a long shelf life[4].

The main objective of the study is to:

- Identify the banana variety and drying method.
- Assess the nutrient content, shelf life, physiochemical properties, and functional properties of composite banana powder made from karpooravalli bananas.
- Analyze the phytochemical and antioxidant activities of various extracts using cabinet-dried composite banana powder.

*Selection of the ingredient :*

The identified ingredient in the study was Karpooravalli banana (***Musa balbisiana***). The ingredients were procured from a local market and utilized for the processing of banana powder.

*Processing of Banana powder :*

Karpooravalli bananas were carefully sorted to eliminate any flawed fruits and thoroughly washed under flowing tap water, then weighed and peeled. Next, the pulp and peel were weighed again and sliced into 2 mm thick pieces using a sharp stainless steel knife. These slices (both the pulp and peel) were promptly immersed in a 0.5% citric acid solution for 3 minutes to prevent enzymatic browning. The treated banana pulp and peel were arranged on perforated stainless steel trays and dried in a cabinet dryer at 120°C for duration of 7–8 hours. After drying, the banana pulp and peel were separately ground into a fine powder. The banana pulp powder and peel powder were subsequently combined in a 50:50 ratio to produce composite flour, which was then stored in airtight containers, aluminum pouches, and polythene bags for future analysis.

*Nutrient analysis :*

Nutrient analysis was performed to ascertain the nutrient profile of the cabinet-dried karpooravalli banana composite powder. Standard methods were employed to analyze various nutrients, including ash, moisture, protein, fat, crude fiber, carbohydrates, energy,

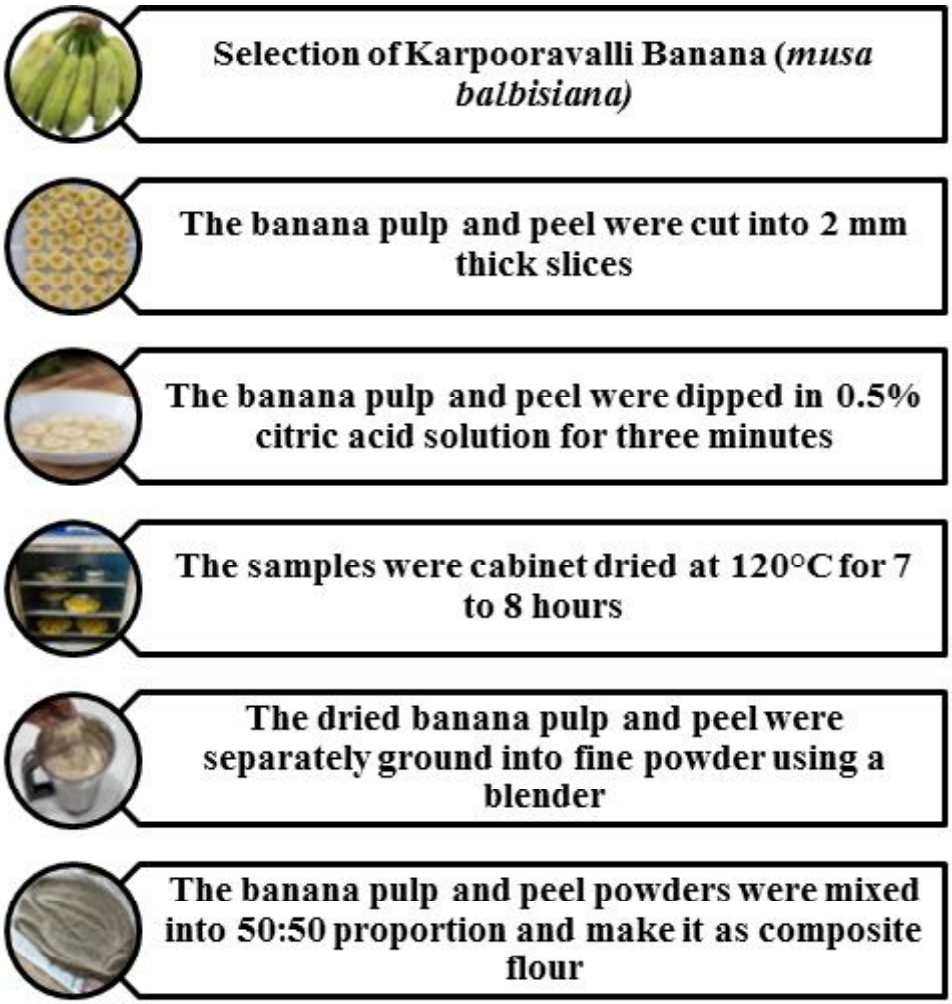



Figure 1. Processing of Banana Powder

calcium, phosphorus, potassium, iron, and vitamin C.

*Shelflife evaluation :*

The shelf life of the cabinet-dried composite karpooravalli banana powder, stored in airtight containers, aluminum pouches, and polythene bags at room temperature, was evaluated through microbial analysis on the 1st, 10th, 20th, and 30th days of the study period to assess the product's longevity.

*Ethical aspects :*

The Ethical Board of Avinashilingam University reviewed and granted approval for this research. All panelists filled out informed consent forms prior to participating in the sensory analysis.

*Physicochemical and functional properties of different dehydrated composite Banana bowder :*

The physiochemical and functional properties of cabinet-dried composite karpooravalli banana powder, including pH, total soluble solids, titratable acidity, bulk density, tapped density, water-holding capacity, and oil-holding capacity have been evaluated. Various approaches were employed to analyze these properties.

pH :

The pH was measured using a calibrated digital pH meter standardized with distilled water at a pH level of 7.0.The pH of the cabinet-dried composite karpooravalli banana powder was measured using this digital pH meter[17].

*Total soluble solids (Tss) :*

The total soluble solids were measured using a hand refractometer. To prepare the sample, 10 grams of composite karpooravalli banana powder were dissolved in distilled water at a ratio of 1:4 (powder to water) for four hours. The mixture was then filtered through cheesecloth. The resulting extract was placed into the prism of the refractometer, and the observations were recorded.

*Titrable acidity :*

Ten grams of the sample were placed to a volumetric flask, and the volume was made up to 100 ml with distilled water. The contents were filtered through Whatman No.1 filter paper. An aliquot of 10 ml was placed into a conical flask, and 2-3 drops of phenolphthalein indicator were added. This solution was titrated against 0.1 N NaOH until a red coloration persisted for at least 15 seconds, indicating the endpoint[26].

$$\text{Titratable Acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times 0.067}{\text{Volume of aliquot taken}} \times 100$$

*Bulk density :*

The bulk density of the sample was measured following the method outlined by Dickson, (2014). A 50 g sample of composite karpooravalli banana powder was placed in a 100 ml measuring cylinder and tapped until a constant volume was reached.

Bulk Density=weight of the sample (untapped)/ volume of the sample (tapped).

*Tapped density :*

The tapped densities of the samples were measured according to the method described by Ozdikicierler *et al*.,[22]. One gram of composite karpooravalli banana powder was placed in a 10 ml graduated measuring cylinder. The cylinder was gently tapped with a glass rod while resting on a smooth, solid surface until there was no further change in volume. The tapped density was then calculated by dividing the mass of the sample by the tapped volume.

$$\text{Tapped density (g/ml)} = \frac{\text{Mass of sample (g)}}{\text{Volume of sample after tapping (ml)}}$$

*Water holding capacity (Wac) :*

The water retention capacity of the

sample was determined using the method described by Mesias and Morales[20]. First, one gram of composite karpooravalli banana powder was mixed with 25 ml of distilled water in a pre-weighed centrifuge tube. The mixture was vigorously vortexed for one minute. After this, the tube was allowed to set at room temperature for 30 minutes before undergoing centrifugation. The sample was centrifuged at 3000 rpm for 20 minutes, after which the supernatant was discarded, and the tubes were weighed again[23]. The water-holding capacity was calculated using the following formula:

$$\text{Water holding capacity} = \frac{W2"W1}{W0} \times 100$$

Where

W0 = Weight of sample

W1 = Weight of centrifuge tube with sample

W2 = Weight of centrifuge tube with sediment

*Oil holding capacity (Oac) :*

The oil holding capacity of the sample was determined using the method described by Lee *et al*.,[18]. First, one gram of composite karpooravalli banana powder was combined with 25 ml of oil in a pre-weighed centrifuge tube. The mixture was then blended with a vortex mixer for 2 minutes. After mixing, the tube was allowed to stand at room temperature for 30 minutes before centrifugation. Following centrifugation at 3000 rpm for 20 minutes, the supernatant was discarded, and the tube was reweighed. Oil-holding capacity was calculated using the following formula:

$$\text{Oil holding capacity} = \frac{W2-W1}{W0} \times 100$$

Where

W0 = Weight of sample

W1 = Weight of centrifuge tube with sample

W2 = Weight of centrifuge tube with sediment

*Phytochemical analysis :*

*Preparation of Aqueous, Ethanol, and Methanol extract :*

Three different extracts were prepared using aqueous, ethanol, and methanol solvents. For each extract, 10 grams of composite karpooravalli banana powder were placed into 100 ml conical flasks. Each mixture was soaked in distilled water, ethanol, and methanol for 24 hours in a dark room, a process known as maceration. After 24 hours, the solvent was carefully poured into another beaker to separate the extract from the residual plant material. The collected extract was then filtered using Whatman No. 1 filter paper and subjected to phytochemical screening.

*Qualitative Phytochemical Screening :*

The aqueous, ethanol, and methanol extracts of composite karpooravalli banana powder were examined using specific reagents to identify the presence of various bioactive compounds, including flavonoids, terpenoids, tannins, alkaloids, and saponins.

*Flavonoid test :*

For the alkaline reagent test, 2 ml of the extract was treated with a few drops of a 20% sodium hydroxide solution. The formation of a bright yellow color, which turned colorless upon the addition of dilute hydrochloric acid, indicated the presence of flavonoids[15].

*Terpenoids test :*

The extract was mixed with 2 ml of chloroform, and 3 ml of concentrated sulfuric acid ($H_2 SO_4$) was carefully layered on top. A reddish-brown coloration at the interface suggested a positive result for terpenoids[3].

*Tannin test :*

In Braymer's test, about 2.5 mg of each extract was boiled in 5 ml of water in a test tube and then filtered through Whatman No. 1 filter paper. Three drops of 0.1% ferric chloride were added, and the appearance of a brownish-green or blue-black precipitate indicated a positive result for tannins[16].

*Alkaloids test :*

In Meyer's test, 1 ml of Meyer's reagent was added to 2 ml of the extract. The formation of a pale-yellow precipitate confirmed the presence of alkaloids[30].

*Saponin test :*

For the foam test, approximately 2 ml of the extract was combined with 6 ml of water in a test tube. The mixture was shaken vigorously, and the formation of persistent foam confirmed the presence of saponins[32].

*Quantitative phytochemical screening :*

*Total Phenol content :*

The concentration of phenolics in the composite karpooravalli banana powder extracts was determined using a spectrophotometric technique. The total phenol content was measured using the Folin-Ciocalteu assay. The reaction mixture consisted of 1 ml of the extract and 9 ml of distilled water in a 25 ml volumetric flask. One ml of Folin-Ciocalteu phenol reagent was added to the mixture, which was then shaken thoroughly. After five minutes, 10 ml of a 7% sodium carbonate ($Na_2CO_3$) solution was added. The final volume of the mixture was adjusted to 25 ml. Standard solutions of gallic acid were prepared in the same manner at concentrations of 20, 40, 60, 80, and 100 µg/ml. After incubating the mixtures for 90 minutes at room temperature, the absorbance of both the test and standard solutions was measured at 550 nm using a UV-visible spectrophotometer, with the reagent blank as a reference. The total phenol content was expressed as milligrams of gallic acid equivalents (GAE) per gram of extract[11].

*Antioxidant activity :*

*DPPH assay :*

The antioxidant activity of the aqueous, ethanol, and methanol extracts of composite karpooravalli banana powder was evaluated using the DPPH radical scavenging assay. A freshly prepared solution of DPPH at a concentration of 0.1 µg/L was created by dissolving 0.0039 g of DPPH in 100 ml of absolute ethanol. In each test tube, 2 ml of the DPPH solution was added to 2 ml of the aqueous extract. After mixing, the solutions were incubated in the dark for 30 minutes. The absorbance was measured at 517 nm using a spectrophotometer. The control sample contained ethanol instead of the antioxidant solution, while the blank sample contained ethanol instead of the DPPH solution. Additionally, an ascorbic acid solution was used

as a positive control, and a calibration curve was established with concentrations ranging from 200 to 1000 µg/ml [19,27]. The percentage of DPPH free radical scavenging was calculated using the following equation:

$$\% \text{ Inhibition} = \{[AC - AS]/AC\} \times 100$$

Where,

AC = absorbance of control

AS = absorbance of sample solution

The $IC_{50}$ values were determined by plotting percentage inhibition against the respective concentrations used, utilizing linear regression analysis.

*Nutrient analysis of cabinet dried composite Karpooravalli Banana powder :*

Nutrient analysis involves evaluating the nutritional profile of foods and food products. The nutrient content of composite banana powders is derived from the combination of the pulp and peel of Karpooravalli bananas. These composite powders are processed using cabinet drying. The analysis includes various parameters, such as ash, moisture, protein, fat, crude fiber, carbohydrates, energy, calcium, phosphorus, potassium, iron, and vitamin C. The nutrient content of the composite Karpooravalli banana powder is presented in Table-1.

The results revealed that mean values of Moisture, Carbohydrates, Energy, Calcium, Phosphorus, Potassium, and Vitamin C in cabinet-dried banana samples 4.47%, 78.85g, 364.8kcal, 80.6mg, 0.41mg, 64.3mg, and 6.02mg respectively. Protein content was significantly higher in cabinet-dried banana powder 7.56g. Cabinet drying showed balanced nutrient retention for certain components, making it a viable alternative in some cases.

Table-1. Nutrient Content of the Cabinet Dried Composite Karpooravalli Banana Powder

| S. No | Nutrient | Composite Karpooravalli Banana Powder (100g) |
|---|---|---|
| 1. | Moisture (%) | 4.47 |
| 2. | Total ash (%) | 7.08 |
| 3. | Protein (g) | 7.56 |
| 4. | Fat (g) | 1.04 |
| 5. | Crude fibre (g) | 2.48 |
| 6. | Carbohydrate (g) | 78.85 |
| 7. | Energy (Kcal) | 364.8 |
| 8. | Calcium (mg) | 80.6 |
| 9. | Phosphorus (mg) | 0.41 |
| 10. | Potassium (mg) | 64.3 |
| 11. | Iron (mg) | 0.0070 |
| 12. | Vitamin C (mg) | 6.02 |

*Microbial analysis of cabinet dried composite Karpooravalli Banana powder :*

Microbial analysis is essential for evaluating the safety and quality of food by assessing any microbial activity present in the food item. This analysis helps identify pathogens that could affect the product's shelf life. Recent advancements in biotechnology have introduced rapid techniques that streamline processes, provide quicker results, and reduce costs[12]. The shelf life of Karpooravalli banana composite powder is preserved through cabinet drying, and the powder is stored in

Table-2. Microbial Load of the Cabinet dried Composite Karpooravalli Banana Powder on Storage

| S.no | Parameter | Total plate count (1st day) | Total plate count (10th day) | Total plate count (20th day) | Total plate count (30th day) |
|---|---|---|---|---|---|
| 1. | Airtight container | <10 CFU/g | <10 CFU/g | <10 CFU/g | <10 CFU/g |
| 2. | Aluminium pouches | <10 CFU/g | <10 CFU/g | <10 CFU/g | <10 CFU/g |
| 3. | Polythene bags | <10 CFU/g | <10 CFU/g | <10 CFU/g | <10 CFU/g |
| Remark | | On the 30th day after sampling NO contamination was found | | | |
| Organism identified | | No Bacterial growth was observed | | | |

airtight containers, aluminum pouches, and polyethylene bags. Over a period of 30 days, the microbial load, measured in CFU/g, was monitored to assess the effectiveness of different packaging materials in maintaining the powder's microbial quality. The results of the microbial analysis for cabinet-dried Karpooravalli banana composite powders stored in various packaging materials are presented in Table-2.

The results presented in Table-2 indicate that no microbial growth was detected in cabinet-dried composite karpooravalli banana powder on the 1st, 10th, 20th, and 30th days. This demonstrates that the composite karpooravalli banana powder is safe for consumption when stored in airtight containers, aluminum pouches, or polythene bags, provided that hygienic conditions and proper handling practices are maintained.

*Physiochemical and functional properties of cabinet dried karpooravalli Banana powder :*

Physicochemical and functional properties of the banana powder prepared from a combination of the pulp and peel of karpooravalli Banana using cabinet drying. The analysis includes parameters such as pH, total soluble solids (TSS), titrable acidity, bulk density, tapped density, water holding capacity, and oil holding capacity. The mean values of physiochemical characteristics of cabinet-dried composite karpooravalli banana powder are presented in Table-3.

Table-3. Physiochemical and functional properties of Cabinet dried Karpooravalli Banana Powder

| S. No | Physiochemical and Functional Properties | Cabinet Dried Banana Powder |
|---|---|---|
| 1. | pH | 5.30 |
| 2. | TSS (°Brix) | 2.6 |
| 3. | Titrable acidity (%) | 0.18 |
| 4. | Bulk density (g/ml) | 0.56 |
| 5. | Tapped density (g/ml) | 0.37 |
| 6. | Water holding capacity (g/g) | 1.88 |
| 7. | Oil holding capacity (g/g) | 1.15 |

The data presented from table-3 indicates that the physicochemical and

functional properties of cabinet-dried composite banana powder are as follows: pH – 5.30, total suspended solids (TSS) – 2.6, titratable acidity – 0.18, bulk density – 0.56 g/ml, tapped density – 0.37 g/ml, water-holding capacity – 1.88 g/g, and oil-holding capacity – 1.15 g/g. The cabinet drying process resulted in intermediate values for most parameters, striking a balance between nutrient retention and functional performance. These findings suggest that drying techniques significantly influence the physicochemical and functional properties of cabinet-dried Karpooravalli banana powders.

*Phytochemical analysis :*

*Qualitative phytochemical screening :*

Phytochemical screening of cabinet-dried composite karpooravalli banana powder prepared using cabinet drying. The extracts were obtained with three solvents aqueous, ethanol, and methanol to determine the levels of flavonoids, terpenoids, tannins, alkaloids, and saponins. The results are presented as appreciable (+++), moderate (++), trace (+), or absent (-), depending on the concentration of each phytochemical. The results of phytochemical composition in different extracts of composite karpooravalli banana powder are depicted in (Table-4).

From the above table-4, it is clearly shown that cabinet-dried composite karpooravalli banana extracts containing flavonoids were most abundant (+++) in methanol extracts, ethanol extracts showed moderate levels (++), aqueous extracts consistently exhibited trace levels (+) of flavonoids. Terpenoids were consistently found in appreciable amounts (+++) in methanol extracts, Ethanol extracts yielded moderate levels (++) of terpenoids, while aqueous extracts showed moderate amounts (++). Tannins were found in appreciable amounts (+++) in ethanol and methanol extracts for cabinet-dried powders. Alkaloids were moderately present (++). Unlike other phytochemicals, alkaloids exhibited minimal variation in levels, regardless of the solvent or drying technique used. Saponins were primarily observed in moderate amounts (++) in methanol extracts, with slight variations depending on the drying method. Cabinet-dried powders showed trace levels (+) or moderate amounts (++) of saponins across ethanol and aqueous extractions.

Table-4. Phytochemical Constituents of Cabinet Dried Composite Karpooravalli Banana Powder Extracts in Aqueous, Ethanol and Methanol

| S. no | Consti-tuents | Aqueous extract | Ethanol extract | Methanol extract |
|---|---|---|---|---|
| 1. | Flavonoids | + | ++ | +++ |
| 2. | Terpenoids | ++ | ++ | +++ |
| 3. | Tannins | ++ | +++ | +++ |
| 4. | Alkaloids | + | ++ | ++ |
| 5. | Saponins | + | + | ++ |

**+++ : Appreciable amounts, ++ : Moderate amounts, + :Trace amounts, - : Complete absence.**

*Quantitative phytochemical screening :*

*Total Phenolic content :*

Diets rich in fruits and vegetables are linked to a lower risk of developing cancer and cardiovascular diseases. The protective effects of these foods are thought to stem from their antioxidant components, such as polyphenols,

which possess both biological and pharmacological properties[25]. The levels of total phenolic compounds in different extracts (aqueous, ethanol, and methanol) of cabinet-dried composite Karpooravalli banana powder are illustrated in Figure 2.

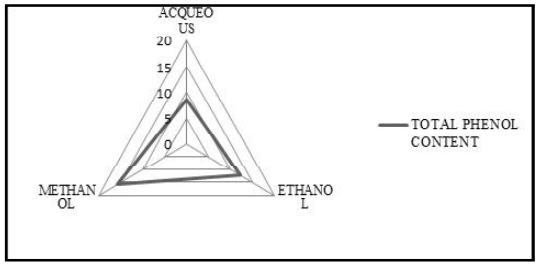


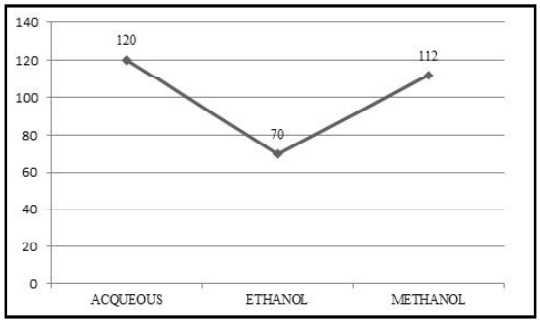

Figure 2
Total Phenolic content of different extracts

According to the data in Figure 2, the total phenolic content of cabinet-dried composite Karpooravalli banana powder is: aqueous – 8.5 mg/ml, ethanol – 12.4 mg/ml, and methanol – 15.6 mg/ml. The higher total phenolic content in cabinet-dried composite Karpooravalli banana powder is consistent with its lower oxidative and thermal degradation during the drying process.

*Antioxidant activity of cabinet dried composite Karpooravalli Banana powder:*

*DPPH Assay :*

The antioxidant activity of composite Karpooravalli banana powder extracts obtained using aqueous, ethanol, and methanol solvents was analyzed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method. Ascorbic acid was used as the standard for comparison. The percentage of scavenging activity for each extract is illustrated in Figure 3.




Antioxidant activity of composite Karpooravalli Banana powder in aqueous, ethanol, And Methanol Extracts
Figure 3

From the above figure 3, shows that DPPH radicals were scavenged by extracts of composite karpooravalli banana powder in a concentration-dependent manner. Among these extracts, the highest $IC_{50}$ value was expressed by aqueous extract 120µg/ml followed by methanol extract 112µg/ml and a lower $IC_{50}$ value of 70µg/ml indicated a higher potential to scavenge free radicals. Hence, from the results of the $IC_{50}$ value of different extracts, the aqueous extract may exhibit maximum and ethanol extracts may exhibit minimum antioxidant properties.

The study highlights that cabinet-dried composite karpooravalli banana powder is rich in protein, fat, crude fiber, carbohydrates, energy, calcium, phosphorus, potassium, iron, and vitamin C. Shelf life assessment verified that this banana powder, when stored in airtight containers, aluminum pouches, or polythene bags, remained stable for 30 days or longer under hygienic conditions. The physicochemical and functional properties of the cabinet -dried composite banana powder are as follows: pH

– 5.30, total soluble solids (TSS) – 2.6, titratable acidity – 0.18, bulk density – 0.56 g/ml, tapped density – 0.37 g/ml, water holding capacity – 1.88 g/g, and oil holding capacity – 1.15 g/g. Phytochemical analysis indicated that the aqueous, ethanol, and methanol extracts of the cabinet-dried composite karpooravalli banana powder contain bioactive compounds such as flavonoids, terpenoids, tannins, alkaloids, and saponins. However, terpenoids were not found in the ethanol extract. The total phenolic content of the composite karpooravalli banana powder was 8.5 mg/ml for the aqueous extract, while both the ethanol and methanol extracts contained 12.4 mg/ml. Antioxidant activity showed that the highest $IC_{50}$ value was recorded for the aqueous extract at 120 µg/ml, followed by the methanol extract at 112 µg/ml, and the ethanol extract, which had a lower $IC_{50}$ value of 70 µg/ml, indicating a greater potential to scavenge free radicals. Therefore, based on the $IC_{50}$ values of the different extracts, it can be concluded that the aqueous extract may exhibit the highest antioxidant properties, while the ethanol extract may demonstrate the lowest.

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