Antioxidant, Antidiabetic and Anti-inflammatory Activities of Pisonia alba Incorporated Value Added Products

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***Abstract*—The present study investigates the antioxidant, antidiabetic, and anti-inflammatory activities of value-added food products incorporated with Pisonia alba, a medicinal plant traditionally used for its therapeutic potential. Pisonia alba leaves were processed and incorporated into selected value-added products, which were then evaluated for their bioactive properties. Phytochemical screening revealed the presence of phenolics, flavonoids, alkaloids, and tannins, indicating a rich source of natural antioxidants. The antioxidant activity was assessed using standard in vitro assays such as DPPH radical scavenging assay, demonstrating significant free radical scavenging potential in Pisonia alba–enriched products compared to control samples.**

Antidiabetic activity was evaluated through α-amylase inhibition assay, where the incorporated products showed dose-dependent inhibitory effects, suggesting their potential role in regulating postprandial hyperglycemia. Anti-inflammatory activity was determined using in vitro protein denaturation and membrane stabilization assays, which revealed significant inhibition of inflammatory markers.

The results indicate that incorporation of Pisonia alba into value-added products enhances their functional and therapeutic properties, highlighting their potential as natural nutraceuticals. The study supports the utilization of Pisonia alba as a functional ingredient in the development of health-promoting foods aimed at managing oxidative stress, diabetes, and inflammation.

***Index Terms*—Pisonia alba; Value-added products; Antioxidant activity; Antidiabetic activity; Anti-inflammatory activity; Functional foods; Nutraceuticals; Phytochemicals**

I. INTRODUCTION

Pisonia alba Span, commonly referred to in vernacular as the “lettuce tree” or “bird-catcher tree,” is a perennial medicinal species belonging to the family Nyctaginaceae, which comprises approximately 33 genera and around 290 species distributed worldwide (Letchuman & Premarathna, 2021). Taxonomically, Pisonia alba is classified within the kingdom Plantae, order Caryophyllales, family Nyctaginaceae, genus Pisonia, and is often synonymized with Pisonia grandis R.Br. due to morphological similarities documented in botanical treatments (Tamizhazhagan & Pugazhendy, 2017). This taxonomic placement aligns it with a group of plants known for both ornamental appeal and medicinal utility, particularly in tropical climates.

Historically, P. alba has been an integral component of traditional medicine systems across Asia and the Indo-Pacific region, where indigenous practitioners have employed its leaves and other parts for managing diverse ailments including inflammation, ulcers, wounds, and metabolic disorders (Tamizhazhagan & Pugazhendy, 2017). In India, the leaves are consumed as part of folk remedies and even as a leafy vegetable, while in alternative medicine they are attributed with analgesic, anti-inflammatory, and hypoglycemic effects, reflecting a long-standing ethnobotanical heritage (Vishnupriya & Ahmed, 2017).

Geographically, P. alba thrives in tropical and subtropical environments, commonly occurring along coastal belts, sandy soils, and open woodlands across India, Southeast Asia, and island ecosystems of the Pacific (basicandappliedzoology.springeropen.com, 2025). Its ecological adaptability and resilience have facilitated wide naturalization beyond its native range, making it accessible for ethnomedicinal use in diverse climatic zones.

The phytochemistry of P. alba underscores its therapeutic relevance, with studies revealing a rich repertoire of secondary metabolites including

phenolics, flavonoids, tannins, quinones, coumarins, glycosides, and terpenoids, which are frequently linked to antioxidant capacity and other bioactivities (Letchuman & Premarathna, 2021; Vishnupriya & Ahmed, 2017). Qualitative phytochemical screening and in vitro assays have demonstrated significant free radical scavenging activity, suggesting potent antioxidant effects that may mitigate oxidative stress implicated in chronic diseases (Letchuman & Premarathna, 2021). In addition to antioxidant potential, P. alba extracts have displayed promising antidiabetic, anti-inflammatory, and antiulcer activities in both in vitro and animal model studies, aligning with traditional claims and supporting its role in metabolic health and inflammatory regulation (Gayasuddin et al., 2022; Christudas et al., 2009 as cited in Pondicherry University thesis).

Moreover, contemporary research extends the benefits of Pisonia alba beyond conventional therapeutic domains. Investigations into its cognitive enhancing and antioxidative effects have shown improvements in memory and oxidative biomarkers in animal models of amnesia, indicating neuroprotective potential (Sriram et al., 2022). Emerging studies also reveal bioactive properties relevant to vector control, with leaf extracts exhibiting larvicidal and pupicidal activities against Aedes aegypti, underscoring potential applications in public health entomology (basicandappliedzoology.springeropen.com, 2025). Additional bioactivity screenings have reported anti-obesity, renoprotective, and anthelmintic effects, broadening the scope of P. alba's pharmacological profile (Uppugalla et al., 2022; Sangameswaran et al., 2023). Collectively, these findings reflect a convergence between ethnobotanical knowledge and modern scientific validation, positioning Pisonia alba as a versatile source of natural bioactives with significant implications for functional food development, phytotherapeutics, and sustainable health interventions.

II. PROCEDURE

A. Selection of functional ingredients

Pisonia alba leaves which is used as functional ingredient should be free from microbes and contamination. The leaves were collected from local market.

B. Processing of Pisonia alba leaves

The quality of Pisonia alba was determined by the drying methods. Sundrying, Shadow drying and Cabinet drying were the methods used for processing of Pisonia alba leaves.

C. Sundrying method

Pisonia alba leaves were washed thoroughly under running water and drained out the water. It was spread on the clean tray.It was dried under sunlight for 2 days and made into fine powder.

D. Cabinet drying method

Pisonia alba leaves were washed thoroughly under running water and drained out the water. It was spread on the clean tray. It was dried under cabinet dryer at 60^0 C for 3 hours and made into fine powder.

E. Shadow drying method

Pisonia alba leaves were washed thoroughly under running water and drained out the water. It was spread on the clean tray. It was dried under shadow for 3 days and made into fine powder.

Figure 1: Fresh leaves of Pisonia alba

Figure 2: Dried leaves of Pisonia alba

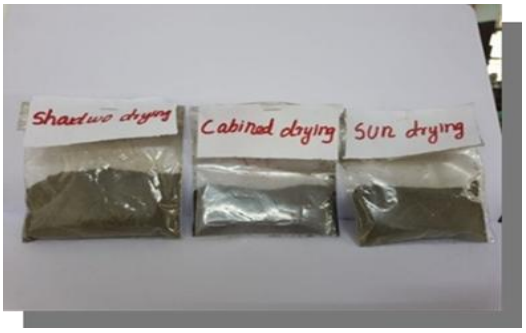

Figure 3: Pisonia alba leaves powder

F. Development and Standardization of Pisonia alba incorporated murukku using sundried powder

The processed Pisonia alba leaves powder was incorporated 5%, 10% and 15% leaves powder into ready to murukku mix and acceptability test was done by ten panel members.

Ingredients	Control	Sample A	Sample B	Sample C
Raw rice Flour	60g	55 g	50 g	45 g
Roasted Bengal gram flour	25g	25g	25g	25g
Pepper	5 g	5 g	5 g	5 g
Red Chilli	10 g	10 g	10 g	10 g
Pisonia alba leaves	-	5 g	10 g	15 g

Table 1: Ingredients used for Pisonia alba leaves incorporated Murukku

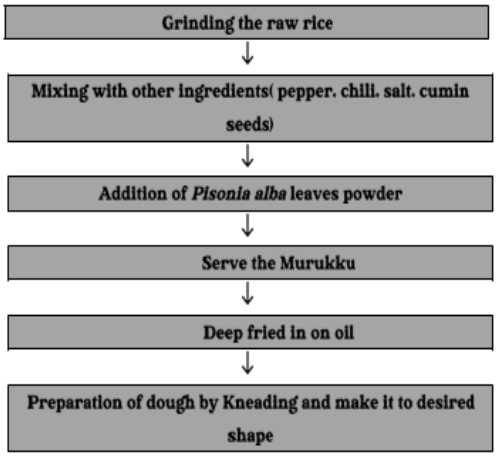

Figure 4: Preparation of Pisonia alba incorporated Murukku

Figure 5: Pisonia alba leaves incorporated Murukku

G. Development and Standardization of Pisonia alba incorporated soup mix

The processed Pisonia alba leaves powder was incorporated 5%, 10% and 15% leaves powder into ready to murukku mix and acceptability test was done by ten panel members.

Ingredients	Control	Sample A	Sample B	Sample C
Beans	25 g	25 g	25 g	25 g
Carrot	25 g	25 g	25 g	25 g
Onion	10 g	10 g	10 g	10 g
Pepper	5 g	5 g	5 g	5 g
Cumin seeds	5 g	5 g	5 g	5 g
Tomato	15 g	15 g	10 g	5 g
Pisonia alba leaves	-	5 g	10 g	15 g

Table 2: Ingredients used for Pisonia alba leaves incorporated soup mix

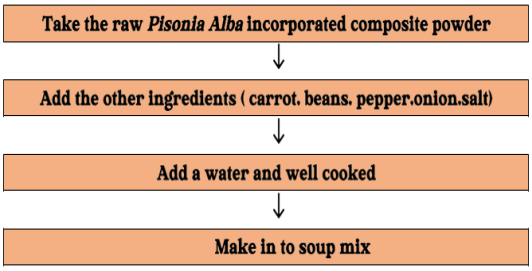

Figure 6: Preparation of Pisonia alba incorporated Soup mix

H. Sensory evaluation of Pisonia alba leaves incorporated value added products

The quality of the food product is assesses by means of human sensory organs, the evaluation is said to a sensory or subjective organoleptic. For evaluating the sensory characteristics, the different formulation of raw Pisonia alba leaves powder incorporated ready to mix products murukku, soup mix were prepared by standardized procedure. They were assessed by 10 panel members. The panelist were asked to determine the sensory attributes on the basic of 5 point hedonic scale and they were scored on basis of sensory qualities such as appearance, colour, texture, taste and odour. The overall acceptability was evaluated by mean score of all the attributes.

I. Nutrient analysis of Pisonia alba value added products

The biochemical composition of the Pisonia alba leaves powder incorporated sample and control sample were analysed and the procedure was given in

(i). Determination of Moisture content

The assessment of water content in foods relies on the reduction in weight upon heating. In this investigation, the moisture content of Pisonia alba leaves powder, control and Selected Pisonia alba leaves powder incorporated food product was determined
using the standard hot air oven method outlined in AOAC (2005).

(ii). Determination of Iron

The iron content of the sample was analyzed using Wong's Method.This method involves converting the iron to the ferric form using an oxidizing agent such as potassium persulfate or hydrogen peroxide, followed by treatment with potassium thiocyanide to form red ferric thiocyanate. The concentration of ferric thiocyanate is then measured calorimetrically at 480nm using a green filter. The iron content was determined for Commelina benghalensis leaves
powder, control and selected Commelina benghalensis leaves powder powder incorporated food products, following the procedures outlined in AOAC (2011).

(iii). Determination of Crude Fibre

Crude fiber refers to the variable amounts of cellulose and lignin present in a sample. The determination of crude fiber involves sequentially extracting the sample with 1.25% sulfuric acid and 1.25% sodium hydroxide. Crude fiber content was assessed for assessed Pisonia alba leaves powder, control and selected Pisonia alba leaves powder
powder incorporated food products.

(iv). Determination of Protein

The protein content of the sample was assessed using Lowry's Method. This method calculates the protein amount based on the nitrogen concentration of the sample. In this study, the protein content was determined for Pisonia alba leaves powder, control and selected Pisonia alba leaves powder incorporated food product using Lowry's Method.

(v) Determination of antioxidant activity

The extract's ability to scavenge free radicals was assessed by measuring its hydrogen-donating or radical scavenging capacity using the stable free radical DPPH. This was achieved using a method similar to that outlined by Keto. A 1mM solution of DPPH in ethanol and a solution of the extract in mg/mL were prepared. Ethanol was then used to prepare a solution, to which 1 mL of DPPH was added. The absorbance was subsequently measured at 517nm against a corresponding blank solution, which consisted of 4 mL ethanol. A control solution was also prepared using 3 mL ethanol and 1 mL DPPH. The assay was conducted in triplicates, and the
percentage inhibition of the free radical DPPH was calculated.

(vi) Determination of antidiabetic activity of Pisonia alba leaves incorporated value-added food product

Four concentration of plant extract were prepared by dissolving double distilled water. There were 25mg/ml, 50 mg/ml, 75mg/ml and 100 mg/ml. A total of 500 µl of plant extract and 500 µl of 0.02 M of

sodium phosphate buffer (pH 6.0 with 0.006 M sodium chloride) containing alpha amylase solution (0.5 mg/ml) were incubated for 10 minutes 25^0 C. After pre incubation, 500 µl of 1% starch solution in 0.02 M sodium phosphate buffer (pH 6.0 with 0.006 M sodium chloride) was added to each tube at 5 s intervals. This reaction mixture was then incubated for 10 minutes at 25^0 C. 1 ml of DNSA colour reagent was added to stop the reaction. These test tubes were then incubated in a boiling water bath for 5 minutes and cooled to room temperature. Finally this reaction mixture was again diluted by adding 10 ml distilled water following which absorbance was measured at 540nm.

Inhibition%=A(control-A(extract)/A(control)x100

(vii) Determination of anti-inflammatory activity of Pisonia alba leaves incorporated value-added food product

The anti-inflammatory activity was studied by using inhibition of albumin denaturation technique which was studied according to Mizushima et.al and Sakat et.al followed with minor modifications. The reaction mixture consists of test extracts and 1% aqueous solution of bovine albumin fraction, pH of the reaction mixture was adjusted using small amount of 1 N HCl. The sample extract were incubated at 37^0 C for 20 minutes and then heated to 51^0 C for 20 minutes, after cooling the samples the turbidity was measured at 660 nm. The experiment was performed in triplicate. The percentage inhibition of protein denaturation was calculated.

(viii) Determination of phytochemicals present in Pisonia alba leaves incorporated value-added food product

Qualitative phytochemicals screening of Pisonia alba leaves powder was carried out for the detection of various constituents such as tannins, alkaloids, saponins, phenols, flavanoids and fatty acids. Phytochemical examinations were carried out for all the extracts as per the standard methods. 10 g of leaves powder was weighed and mixed with 100 ml of ethanol in a beaker. It is boiled for some minutes. After that it was filtered with Whatmann No.1 filter paper. The filtrate was used for the further phytochemical analysis.

(ix) Determination of microbial profile of Pisonia alba leaves incorporated value-added food product

The microbial load was carried out to find out the shelf life of Pisonia alba leaves powder using the standard plate count method. The microbial load was determined for 30 days at 10-day intervals using the standard plate count method.

(ix) Cost analysis of the selected standardized Pisonia alba leaves powder incorporated value-added product

Cost examination was finished considering the new natural substances, work cost, and power. The expense was determined for the 100g of the developed products.

III. RESULT AND DISCUSSION

A. Sensory evaluation of Pisonia alba leaves incorporated Murukku

The developed products were subjected to sensory evaluation by panel members and the score obtained for 5%, 10% and 15% Pisonia alba leaves incorporated Murukku was found and statistically analyzed.

Characteristics	Control	Sample A	Sample B	Sample C
Colour	4.5 ±0.03	3.5 ±0.10	4.6 ±0.08	4.2 ±0.02
Flavour	4.7 ±0.08	3.2 ±0.07	4,7 ±0.17	3.4 ±0.03
Texture	4.5 ±0.08	3.4 ±0.06	4.5 ±0.16	4.5 ±0.09
Taste	4.6 ±0.17	3.4 ±0.08	4.6 ±0.10	3.6 ±0.08
Overall acceptability	4.6 ±0.08	3.5 ±0.10	4.7 ±0.17	3.9 ±0.15

Table 3: Sensory evaluation of Pisonia alba leaves incorporated Murukku

The above table 4 shows the mean score of colour, flavor, texture, taste and overall acceptability of the Pisonia alba leaves powder incorporated Murukku. It was found that overall acceptability of sample B was 4.7. But the other two samples A and C got the overall acceptability of 3.5 and 3.9 respectively. Therefore 75 % of the Pisonia albaleaves powder incorporated Murukku was excellent mean score with the other two

incorporations. So sample B was selected for the product development.

A. Sensory evaluation of Pisonia alba leaves incorporated Soup mix

The developed products were subjected to sensory evaluation by panel members and the score obtained for 5%, 10% and 15% Pisonia alba leaves incorporated Soup mix was found and statistically analyzed.

Characteristics	Control	Sample A	Sample B	Sample C
Colour	4.7 ±0.03	3.5± 0.10	4.6± 0.08	4.2± 0.02
Flavour	4.7 ±0.05	3.2± 0.07	4.8± 0.18	4.4± 0.03
Texture	4.5 ±0.08	3.4± 0.06	4.5± 0.06	4.5± 0.05
Taste	4.9 ±0.19	3.4± 0.08	4.5± 0.09	3.6± 0.02
Overall acceptability	4.9 ±0.18	3.5 ±0.10	4.8 ±0.18	3.7 ± 0.15

Table 4: Sensory evaluation of Pisonia alba leaves incorporated Soup mix

The above table 4 shows the mean score of colour, flavor, texture, taste and overall acceptability of the Pisonia alba leaves powder incorporated soup mix. It was found that overall acceptability of sample B was 4.8. But the other two samples A and C got the overall acceptability of 3.5 and 3.7 respectively. Therefore 75 % of the Pisonia alba leaves powder incorporated Soup mix was excellent mean score with the other two incorporations. So sample B was selected for the product development.

C. Nutrient analysis

The nutrient content of Pisonia alba leaves powder incorporated value added products was analyzed and given in table 5.

Nutrient	Value(g)
Carbohydrates	19.8g
Protein	26.2g
Crude fiber	12.3g
Moisture	38.3%
Iron	12mg

Table 5: Nutrient analysis

The nutrient content of Pisonia alba leaves powder was found as carbohydrates 19.8g, protein26g, crude fiber 12.g, Moisture38.3%, Ash 8.06%, iron 12mg%.

(i)Determination of Moisture

Sample	Control %	Sample %
Murukku	2.20	2.56
Soup mix	4.6	4.18

Table 6: Estimation of Moisture

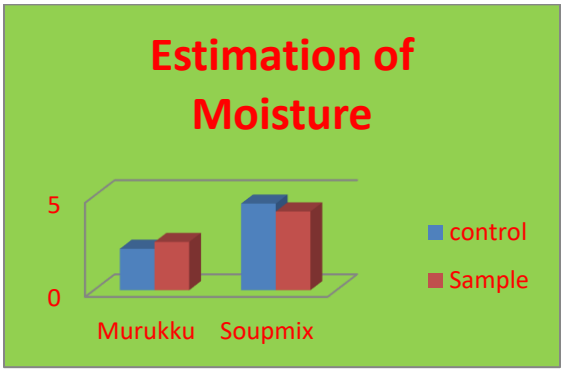

Figure 8: Estimation of Moisture

Table 6 and figure 8 present the moisture content of the control sample and Pisonia alba leaves powder incorporated products were determined using hot air oven method. The weight of the sample was noted until the weight remains constant.

(ii)Determination of Protein.

Sample	Control %	Sample %
Murukku	65	81
Soup mix	56	78

Table 7: Estimation of Protein

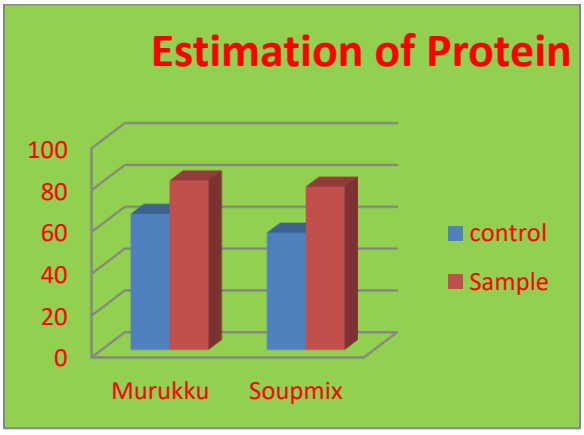

Figure 9: Estimation of Protein

Table 7 and Figure 9 present the protein content of the sample was determined by the Lowry's method. Proteins are essential for muscle development and body building.

(iii)Determination of Carbohydrates

Sample	Control %	Sample %
Murukku	90.47	93.65
Soup mix	54.87	60.92

Table 8 : Estimation of Carbohydrates

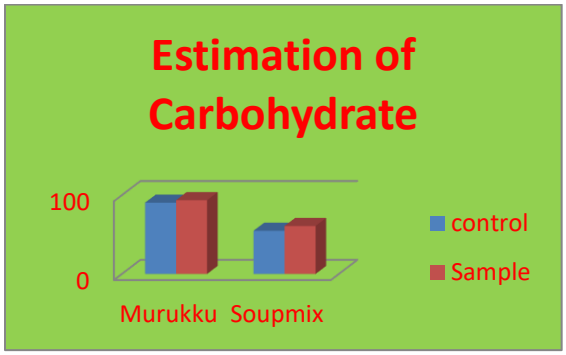

Table 8 : Estimation of Carbohydrates

Table 8 and Figure 10 shows the Carbohydrates content of control sample and Pisonia alba leaves Incorporated Murukku and Soup mix. The control sample had 6.56 g of carbohydrates and Pisonia alba leaves powder incorporated Murukku had 19.5 g of Carbohydrates. The control sample had 6.56 g of Carbohydrates and Pisonia alba leaves powder incorporated soup mix had 21.87 g of Carbohydrates.

(iv)Determination of Fibre

Sample	Control %	Sample %
Murukku	16.06	20.44
Soup mix	5.68	7.94

Table 9: Estimation of Fibre

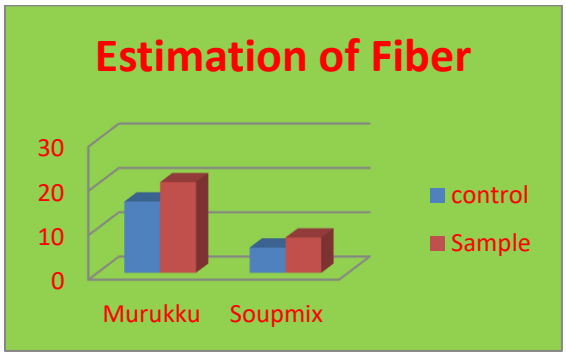

Figure 11: Estimation of fiber

Table 9 and Figure 11 shows the fiber content of control sample and Pisonia alba leaves Incorporated Murukku and Soup mix. The control sample had 16.06 g of fiber and Pisonia alba leaves powder incorporated Murukku had 20.44g of fiber. The control sample had 5.68 g of fiber and Pisonia alba leaves powder incorporated soup Mix had7.94 g of fiber.

(iv) Determination of Iron

Sample	Control %	Sample %
Murukku	13.16	15.44
Soup mix	18.68	20.36

Table 10: Estimation of Iron

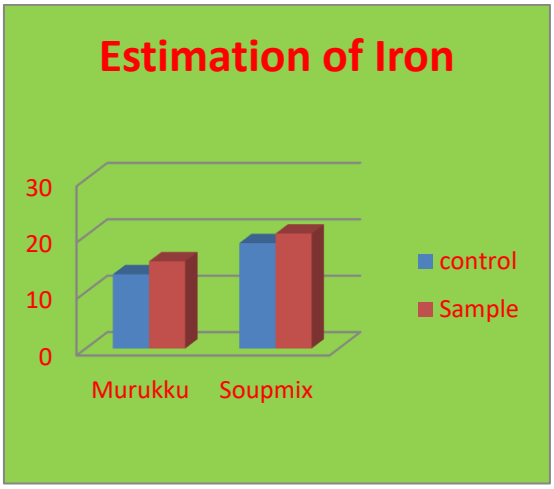

Figure 12: Estimation of Iron

Table 10 and Figure 12 shows the iron content of control sample and Pisonia alba leaves Incorporated Murukku and Soup mix. The control sample had 13.16 g of iron and Pisonia alba leaves powder incorporated Murukku had 15.44 g of iron. The control sample had 18.68 g of iron and Pisonia alba leaves powder incorporated soup Mix had 20.36 g of iron.

D. Analysis of antioxidant activity

Sample	Water	Ethanol
Sun drying	97%	86%
Cabinet drying	65.46%	66.45%
Shadow drying	48.94%	57.77%
Murukku	65.89%	60%
Soup mix	63.67%	59.34%

Table 11: Antioxidant activity of Pisonia alba leaves and Pisonia alba leaves incorporated value added food products

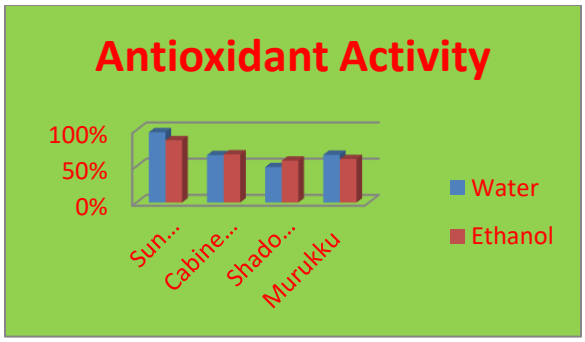

Figure 13: Antioxidant Activity

The Antioxidant activity content of Pisonia alba Powder was shown in Table 11 and Figure 13.The research revealed that the Antioxidant activity of Pisonia alba Powder was 97%. The antioxidant activity of Sample Murukku was found to be 51%. The antioxidant activity of Sample Soup mix was found to be 63.67%.

E. Anti-diabetic activity

Concentration	Sample	Inhibition		
0.25	Pisonia alba Powder	62.5%	75%	83.33%
0.50	Acarbose	25%	58.83%	66.67%
0.75	Murukku	22%	35.24%	49.97%
1.0	Soup mix	45%	52.22%	60.33%

Table 12: Anti-diabetic activity of Pisonia alba leaves and Pisonia alba leaves incorporated value added food products

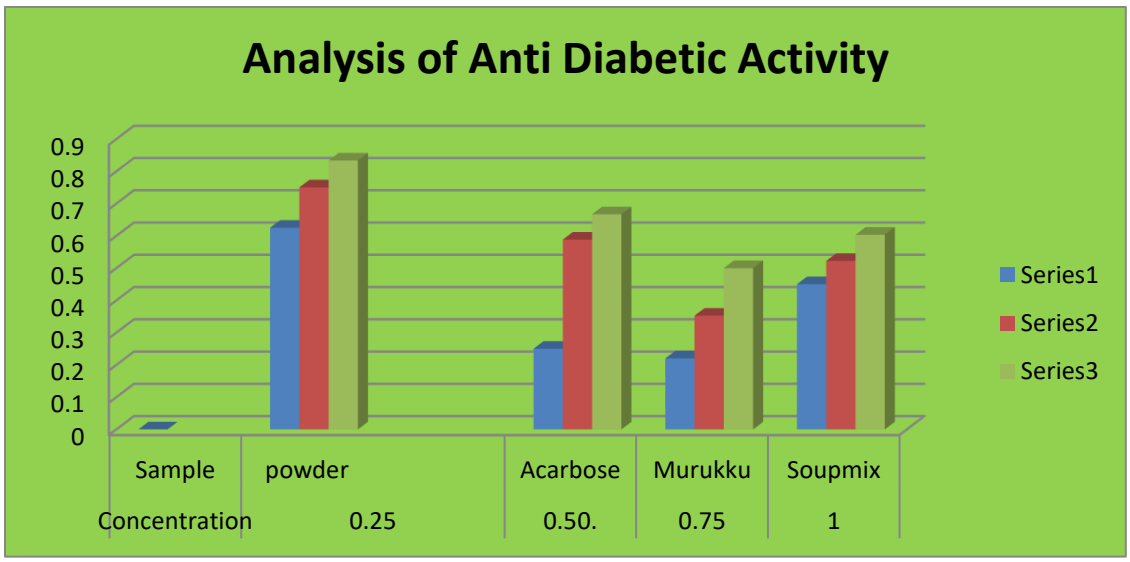

Figure 14: Anti-diabetic activity

All determination was carried out in triplicate manner and values are expressed as the inhibition percentage. The value is defined as the concentration of inhibitor to inhibit 50% of its activity under the assayed conditions. In Pisonia alba leaves and products extract, inhibit at the concentration level 0.75 to 1.0. in these concentration level brings the inhibition percentage range Murukku 49.97% and Soup mix 60.33%

F. Anti-inflammatory activity

Sample	Activity
Pisonia alba leaves	70%
Murukku	56.43%
Soup mix	63.89%

Table 13: Anti-inflammatory activity of Pisonia alba leaves and Pisonia alba leaves incorporated value added food products

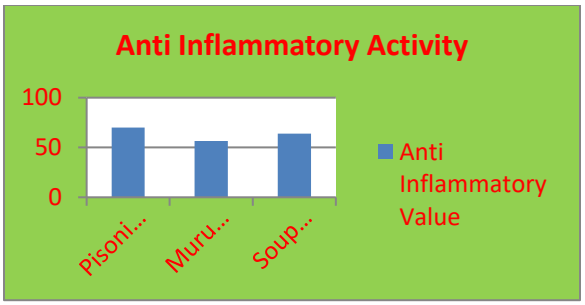

Figure 15: Analysis of Anti-inflammatory activity

Table 13 and Figure 15 shows the Anti – Inflammatory activity of control sample and Pisonia alba leaves Incorporated Murukku and Soup mix.

G. Phytochemical analysis

	Sun Drying	Shadow drying	Cabinet drying	Murukku	Soup mix
Carbohydrates	+	+	+	+	+
Phenol	+	+	+	+	+
Tannins	+	+	-	-	+
Flavanoids	+	+	+	+	+
Coumarins	-	+	-	-	+
Amino acids	+	-	+	-	+
Saponins	+	+	+	+	+
Terpenoids	+	-	-	+	-
Alkaloids	-	-	-	-	+
Starch	-	-		+	-

Table 14: Phytochemical analysis of Pisonia alba leaves and Pisonia alba leaves incorporated value added food products

H. Microbial analysis

Sample	Microbes	Microbial load at room temperature		
		Initial	15th day	30th day
Pisonia alba leaves	Bacteria	-	TFTC	TFTC
Murukku	Bacteria	-	TFTC	TFTC
Soup mix	Bacteria	-	TFTC	TFTC

Table 15: Storage studies of Pisonia alba leaves and Pisonia alba leaves incorporated value added food products at room temperature

Sample	Microbes	Microbial load at refrigeration temperature		
		Initial	15th day	30th day
Pisonia alba leaves	Bacteria	-	TFTC	TFTC
Murukku	Bacteria	-	TFTC	TFTC
Soup mix	Bacteria	-	TFTC	TFTC

Table 16: Storage studies of Pisonia alba leaves and Pisonia alba leaves incorporated value added food products at refrigeration temperature

In microbial analysis, the above table 15 and table 16 shows the result of the microbial load of Pisonia alba leaves powder and also for the Pisonia alba powder enriched baked products which were kept in room temperature and refrigeration temperature. During the analysis, it was found that the products had too few to count microorganisms at refrigeration temperature where the products had too numerous to count microorganisms at room temperature

Cost analysis

Cost benefit analysis is used to evaluate the risks and rewards of project under consideration. It can be used to project the potential benefits of investing in marketing ideas, product development, infrastructure enhancements and operational changes. Cost analysis was done by considering the raw materials, labor cost and electricity used for the research. The cost was calculated for 100g of the selected Pisonia alba Leaves Powder Incorporated food products such as the Murukku was found as Rs 10, for soup mix found as Rs. 15/-.

IV. CONCLUSION

The present study demonstrates that incorporation of into value-added products significantly enhances their functional and therapeutic potential. The formulated products exhibited appreciable antioxidant activity, as evidenced by their strong free radical scavenging ability, which can be attributed to the presence of bioactive phytoconstituents such as phenolics, flavonoids, and other secondary metabolites inherent to P. alba. These antioxidant properties suggest a protective role against oxidative stress–mediated cellular damage.

Furthermore, the antidiabetic activity of the – incorporated products was evident through their inhibitory effects on carbohydrate-hydrolyzing enzymes and/or glucose-modulating potential, indicating their possible role in regulating postprandial hyperglycemia. This highlights the promise of P. alba as a natural source for developing functional foods or nutraceuticals aimed at diabetes management.

The products also demonstrated significant anti-inflammatory activity, suggesting their ability to modulate inflammatory mediators and pathways. This activity supports the traditional use of in managing inflammatory conditions and further validates its inclusion in health-oriented food formulations.

Overall, the present study shows Pisonia alba leaves as a functional food or nutraceutical ingredient, though further in vivo, safety, and clinical studies are needed to confirm its efficacy and applicability.

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