FORMULATION AND STANDARDIZATION OF COCOA- BASED NUTRITIONAL POWDER ENRICHED WITH JACKFRUIT SEED POWDER, COCONUT SUGAR AND ALMOND POWDER

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Abstract:
Cocoa powder is widely valued in the food industry for its distinctive flavor, functional properties, and richness in polyphenols and essential minerals. It is obtained by grinding roasted cocoa nibs and removing most of the cocoa butter, resulting in a nutrient-dense powder. In this study, cocoa powder was enriched with jackfruit seed powder, coconut sugar, and almond powder to formulate a health-promoting nutritional supplement. Jackfruit seed powder, prepared through boiling, dehulling, drying, and grinding, is rich in resistant starch, protein, and phenolic compounds, making it a suitable gluten-free, functional flour. Coconut sugar, derived from the sap of coconut palm, was processed into a fine powder and contributes a low glycemic index, along with minerals such as iron, potassium, and zinc. Almond powder, produced by blanching, drying, and milling almonds, is high in protein, fiber, vitamin E, and healthy fats. The study aimed to develop and standardize this cocoa-based powder by evaluating its physicochemical characteristics, nutritional composition, and sensory acceptability. Macronutrient content including protein, fat, carbohydrates, fiber, and ash was assessed, alongside sensory parameters such as taste, texture, aroma, and overall appeal. The final formulation was optimized for both nutrition and consumer preference. This research supports the development of a cost-effective, functional food product as a nutritious alternative to conventional cocoa powders.

Keywords: Cocoa powder, Jackfruit seed powder, Coconut sugar, Almond powder, Functional foods, Protein, Fiber.

1.INTRODUCTION

In recent years, there has been a marked increase in consumer interest toward functional foods, driven by growing awareness of health, nutrition, and disease prevention. Functional foods, defined as those that offer health benefits beyond basic nutrition, are increasingly being incorporated into daily diets to combat lifestyle-related disorders such as diabetes, obesity, cardiovascular diseases, and digestive issues (Scheinbach, 1998). Consumers today focus not only on caloric intake but also on the nutritional quality and origin of their food. This shift has encouraged the development of fortified and naturally functional food products. Nutritional powders derived from plant-based ingredients are gaining popularity due to their convenience and ability to deliver essential nutrients efficiently. Cocoa-based nutritional powders, in particular, are widely accepted across age groups because of their flavor, ease of consumption, and potential health-promoting properties. Cocoa is a rich source of polyphenols—especially flavonoids such as catechins, anthocyanins, and procyanidins—which have been shown to exert antioxidant, anti-inflammatory, and cardio-protective effects (Belščak-Cvitanović et al., 2010). In addition, cocoa provides small but valuable amounts of magnesium, potassium, and iron (Rucker, 2009). However, commercial cocoa products often contain refined sugars and synthetic additives, limiting their health benefits. To enhance the nutritional value of cocoa-based powders, the present study incorporates three natural, functional ingredients: jackfruit seed

powder, coconut sugar, and almond powder. These ingredients not only increase the nutritional density of the product but also align with sustainable and health-conscious food practices. Jackfruit seed powder, often underutilized, is a valuable byproduct containing fiber, resistant starch, protein (7–10%), and key micronutrients such as calcium, iron, and phosphorus (Priyadasini, 2024). It has notable antioxidant and prebiotic potential, supporting digestive health and metabolic balance. Its neutral taste and thickening properties make it suitable for dry powder formulations. Coconut sugar, derived from the sap of coconut palm flowers, is a traditional sweetener with a low glycemic index and contains trace elements like potassium, zinc, and magnesium. It also includes inulin, a prebiotic fiber that supports gut microbiota (Luthfiyah et al., 2019). Almond powder is a nutrient-rich ingredient made by grinding raw or blanched almonds. It contains high levels of monounsaturated fats, plant protein, vitamin E, and magnesium, all of which contribute to heart health and immune function. Almonds have been consumed for centuries and are now popular in gluten-free and health-oriented formulations due to their dense nutritional profile (Holkar, Jadhav, & Pinjari, 2019).

2.LITERATURE REVIEW

Cocoa is a rich source of bioactive compounds, especially flavonoids such as catechins and epicatechins, which have been linked to antioxidant and cardioprotective benefits (Katz et al., 2011). It contains theobromine and caffeine, along with essential minerals like magnesium, iron, and copper (Basu et al., 2011). Cocoa is commonly used in confectionery, beverages, and functional food formulations due to its flavor and health-promoting components (Martinez-Pinilla et al., 2015). Jackfruit seed powder is a nutrient-rich ingredient, high in carbohydrates, particularly resistant starch, which contributes to dietary fiber intake (Swami et al., 2012). It contains protein, calcium, and iron and has demonstrated antioxidant activity due to the presence of phenolic compounds (Baliga et al., 2011). It can be used as a functional flour in bakery products and is considered a suitable gluten-free alternative (Ocloo et al., 2010). Coconut sugar, derived from the sap of coconut palm, is considered a healthier alternative to table sugar. It has a lower glycemic index and contains small amounts of minerals such as potassium, zinc, and iron (Philippine Coconut Authority, 2012). It also includes inulin, a prebiotic fiber beneficial for gut health (Tan et al., 2014). It is widely used in health-conscious and diabetic-friendly formulations. Almond powder is known for its high content of healthy monounsaturated fats, protein (about 21%), fiber, and essential micronutrients such as vitamin E and magnesium (Berryman et al., 2011). It also contains antioxidants and phytosterols, making it a valuable ingredient in functional foods and gluten-free recipes (Chen et al., 2006). Almonds are commonly incorporated into energy bars, desserts, and bakery items.

3. MATERIALS AND METHODS:

Raw materials: Some of the raw materials required for development of cocoa-based nutritional powder are Cocoa powder, Jackfruit seed powder, Coconut sugar and Almond powder.

Preparation of Cocoa powder:

Fresh, high-quality cocoa beans (moisture 7–8%) were cleaned using a classifier, drum magnet, and destoner. Beans were then heated in an IR micronizer to loosen shells, broken in a breaker, and passed through a winnower to separate nibs. The nibs were alkalized to adjust pH and color, with process parameters optimized per bean variety. Alkalized nibs were roasted (>100°C), cooled, and ground into cocoa liquor. Cocoa butter was partially extracted using a hydraulic press, and the remaining cake was milled and sieved to obtain fine cocoa powder.

Preparation of Jackfruit seed powder:

Collected mature jackfruit seeds from ripe fruits, washed them thoroughly, and boiled them to soften and remove the outer seed coat. The peeled seeds were sliced into smaller pieces and dried in a hot air oven at 60°C until fully dehydrated. The dried pieces were then ground into a fine powder and sieved to achieve a smooth, uniform texture.

Preparation of Coconut sugar:

Used commercially tapped coconut sap, which was immediately boiled to prevent fermentation. Continued boiling until the sap thickened into a syrup and then stirred the syrup constantly until it crystallized. The crystals were dried to remove residual moisture and then sieved to obtain fine coconut sugar.

Preparation of Almond powder:
Selected clean, good-quality almonds and lightly roasted them to improve flavour and increase shelf stability. Once cooled, the almonds were finely ground using a food-grade grinder and sieved to produce almond powder with uniform particle size suitable for mixing.

FLOW CHART OF INSTANT DOSA MIX

Ingredient Selection and sourcing
↓
Cleaning and Pre-Processing
Jackfruit seeds: Washed, Dried, and ground into powder
Almonds: Ground into fine powder
Cocoa Powder and Coconut sugar: Processed and Screened for impurities
↓
Ingredient Mixing
Combine cocoa powder, jackfruit seed powder, coconut sugar and almond powder in predetermined proportions
↓
Homogenization
Blend thoroughly to ensure uniform distribution of ingredients
↓
Quality Testing
Evaluate physiochemical properties (moisture content, nutritional composition)
↓
Packaging
Seal in food- grade, airtight containers to maintain freshness
↓
Storage
Store in a cool, dry place

Formulations
The Formulations of cocoa-based nutritional powder enriched with jackfruit seed powder, coconut sugar and almond powder based on the sensory, acceptance of the consumers, physicochemical and nutritional properties.

Table:1 formulations

Ingredients	**Sample 1 (100gms)**	**Sample 2 (100gms)**	**Sample 3 (100gms)**
Cocoa powder	40 gms	35 gms	30 gms
Jackfruit seed powder	25 gms	20 gms	15 gms
Coconut sugar	20 gms	30gms	40 gms
Almond powder	15 gms	15gms	15 gms

METHODS
Moisture content: To measure the accurate amount of water present in the sample. Moisture content is analyzed by the oven drying method at 105℃ for 3hrs (AOAC 2000).
Formula: Moisture = W 2 /W 1 ×100%
Ash content: To measure the minerals present in it. Ash content is analyzed by using muffle furnace at 550℃ for 6hrs (AOAC 2000).
Formula: Ash = W 2 /W 1 ×100%

pH: It is determined by the digital pH meter.

Acid Insoluble Ash: To measure contaminants like sand in the sample Formula: Acid insoluble ash = weight of residue after acid treatment × 100%

Original weight of the sample

Fat: To measure the fat content present in the sample

Formula: Free Fat Content: $\frac{10000 \text{ x weight of fat}}{(100- \text{Moisture}) * \text{Sample of weight}}$

Carbohydrates: the measure of carbohydrates is by using fehling solution performed according to FSSAI manual method.

Formula: Total Carbohydrates (%) = Volume of sample used (ml)×dilution factor×100

Protein: the protein content is determined by kjeldahl method.

Formula: Nitrogen% = (Volume of HCl × Normality of HCl×1.4007)

Weight of sample in gm Protein (%) = Nitrogen (%) × 6.38

Crude fiber: Determined using the method of AOAC (2000).

Formula: Crude fibre = Weight of the fibre [(W2-W1) - (W3-W1)] × 100

Weight of the sample (g)

Sensory Analysis: the sensory analysis is done according to hedonic scale rating (table 2). The formulations are exposed to sensory analysis along with control. Different panelist gave the rating for sensory attributes like color, flavor, taste, appearance, taste and overall acceptability. The mean score is the overall acceptability.

Table: 2 Hedonic Scale

OPINION	RATING
Like extremely	9
Like very much	8
Like moderately	7
Like slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

4.RESULTS

Sensory Analysis: According to sensory analysis the formulation 3 that is 30 grams of cocoa powder, 15 grams of jackfruit seed powder, 25 grams of coconut sugar, 15 grams of almond powder is the best among the 3 as it has highest rating due it is better in taste, appearance and texture. The overall acceptability for the formulation 1 is 6.6, formulation 2 is 7.6, formulation 3 is 8.4.

Table:3 Sensory Analysis

Sensory Attributes	Control Sample	Sample 1	Sample 2	Sample 3
Colour	9	7	8	9
Flavour	8	7	8	8

Consistency	9	7	8	8
Taste	8	6	7	8
Appearance	9	6	7	9
Overall acceptability	8.6	6.6	7.6	8.4

Physico Chemical Analysis

According to the results of physico-chemical analysis, it clearly states that developed and optimized variation (Sample 3) was the best compared to the control sample and other formulations**.** The developed product has moisture, ash, acid insoluble ash and pH within the range, suitable for the shelf life of the product and for the consumers acceptance.

The formulation 3 has 5.46% pH, 4.50% moisture content, 4.85% ash, 0.32% acid insoluble ash.

Table: 4 Physico Chemical Analysis

Parameters	**Control Sample**	**Sample 1**	**Sample 2**	**Sample 3**
pH	5.50	5.45	5.44	5.46
Moisture	4.0	5.20	4.90	4.50
Ash	4.70	3.89	4.37	4.85
Acid Insoluble Ash	0.32	0.28	0.30	0.32

Nutritional Analysis

The nutritional analysis of 3 formulations are given in the below table. According to the sensory evaluation the formulation 3 is the best as it has high protein, fiber when compared to control. The cocoa based nutritional powder enriched with jackfruit seed powder, coconut sugar and almond powder is rich in nutrients which it can be healthy when it is consumed. The formulation 3 has 62.0g of carbohydrates, 11.0g of protein, 10.0g of fiber, 11.39g of fat.

Table: 5 Nutritional Analysis

Parameters	**Control Sample**	**Sample 1**	**Sample 2**	**Sample 3**
Fat	11.45	8.50	9.94	11.39
Protein	12.35	8.0	9.0	11.0
Carbohydrates	65.35	68.0	65.0	62.0
Fiber	10.85	8.0	9.0	10.0

Sample 3 was found to be the best among all formulations. It was good in flavour, taste, and overall acceptability, making it highly preferred in the sensory analysis. Nutritionally, it is rich in carbohydrates and has a lower fat content, which makes it a healthy option. Sample 3, on the other hand, is rich in protein. Overall, Sample 3 is both tasty and nutritious, making it the most suitable formulation.

5.CONCLUSION

The cocoa-based nutritional powder enriched with jackfruit seed powder, coconut sugar, and almond powder represents a balanced and functional food product that effectively merges taste, nutrition, and convenience. Rich in essential nutrients, antioxidants, and dietary fiber, it offers multiple health benefits including improved digestion, cardiovascular support, and blood sugar regulation. Its clean-label formulation, free from artificial additives, aligns with current consumer preferences for natural and health-promoting products. With its versatility as a health drink or ingredient in various recipes, the powder fits seamlessly into modern dietary habits. Overall, the product addresses nutritional gaps while promoting wellness, making it a valuable contribution to the functional food sector.

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