Formulation and Evaluation of Nutrient Enriched Coconut Milk Powder - Plant Based Protein Supplement

[1]SINTHIYA R, [2]KISHORE KUMAR J, [2]MIRNALINI G, [2]AKASH S,[2]KOMALA S,[2]VIGNESH R
[1]Assistant Professor, Department of Food Technology, Sri Shakthi Institute of Engineering and Technology, Coimbatore-641062.
[2]Scholars of Food Technology, Department of Food Technology, Sri Shakthi Institute of Engineering and Technology, Coimbatore-641062.

ABSTRACT

This study focused on developing coconut milk powder enriched with cashew and almond paste to improve its protein and micronutrient profile. Freshly extracted coconut milk, which is naturally high in fat, was blended with the nut paste and converted into powder using spray drying at an inlet temperature of 190 °C and an outlet temperature of 90 °C. Maltodextrin was added as a carrier agent to enhance drying performance and minimize separation during processing. The final product exhibited good solubility and could be reconstituted easily in water at both room and higher temperatures, forming a stable and uniform solution. Initial storage evaluation showed that the powder maintained acceptable quality for up to three months when packed in polyethylene pouches and stored under ambient conditions. The study confirms that incorporating cashew and almonds into coconut milk and processing it through spray drying results in a nutritionally improved, storage-stable powder suitable for use as a plant-derived replacement for conventional dairy.

INTRODUCTION

Coconut milk is a natural oil-in-water emulsion with 30–35% fat, which is substantially higher than the 3–4% typically found in cow's milk (Seow & Gwee, 1997; Prades et al., 2016). Its lipid fraction is primarily made up of saturated fatty acids such as lauric and myristic acids, with smaller contributions from unsaturated fatty acids like linoleic acid.

Although nutritionally beneficial, this elevated fat content reduces the stability of coconut milk and creates difficulties in processing, particularly in tropical environments where storage conditions accelerate spoilage. Spray drying of coconut milk often faces challenges due to high oil content, but the use of carrier agents has shown to improve powder stability. Ghosh et al. (2019) reported that combining maltodextrin with sodium caseinate reduced surface oil and enhanced emulsion stability.

Prasert and Apintanapong (2020) further found that inlet temperatures of 150–160 °C improved solubility and reduced free fat, while Rajendran et al. (2021) noted that excessive heat caused ruptured particles and poor reconstitution. These studies highlight the need for optimized formulations and conditions to obtain high-quality coconut milk powder.

These findings provided a foundation for further exploration into formulation strategies that enhance both stability and shelf life.

More recently, research interest has shifted towards the development of nutritionally superior coconut milk powders by incorporating plant-based protein sources. Cashews and almonds, which are rich in protein, essential fatty acids, vitamins, and minerals, have been recognized as promising fortificants in such formulations.

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TABLE 1

Composition of Coconut Milk and Cow Milk

	Coconut Milk*	Cow Milk**
Protein %	3.4	3.5
Fat %	19	4.0
Water %	73.6	87.5

***Source:** Albuquerque, T.G., et al. (2023)

****Source:** Bibi, Husain & Niger (2024)

TABLE 2

Composition of Free Fatty Acids in Coconut Milk

	%
Caprylic acid	10.0
Capric acid	6.0
Lauric acid	48
Myristic acid	18
Palmitic acid	9
Palmitoleic acid	2.6
Stearic acid	3.7
Oleic acid	10.6
Linoleic acid	1.4

Source: Karunasiri et al., (2020)

Their inclusion not only improves nutritional properties but also meets the increasing consumer preference for plant-derived alternatives to dairy products. Maltodextrin has also been widely applied as a carrier in spray drying, since it supports the drying process, minimizes oil separation, and enhances the solubility of the powder upon reconstitution.

Building on these earlier findings, this study investigates the formulation of coconut milk powder fortified with cashew and almonds, with the goal of enhancing both nutrient value and storage stability through spray drying

MATERIALS AND METHODS

Mature coconuts were collected from nearby markets, dehusked, and processed

by grating. The grated material was blended with warm water in a kitchen blender to facilitate milk extraction. The resulting slurry was passed through a muslin cloth to separate the liquid, yielding fresh coconut milk. After blanching and peeling, cashew nuts and almonds were finely ground into a paste and blended with coconut milk in set proportions to boost protein and micronutrient content. Maltodextrin (5–7% w/w) was incorporated as a carrier and drying aid to improve spray-drying efficiency and minimize phase separation. The fortified coconut milk mixture was homogenized at high speed for 15 minutes to produce a stable emulsion. Spray drying was carried out using an Anhydro Spray Dryer operated at an inlet temperature of 190 °C and an outlet temperature of 90 °C, with a feed rate of 9.3×10^{-6} m³/s and an atomizing pressure of 30 psi (2.0 bar).

After collection, the powder was packed in polyethylene bags and stored under ambient conditions until further testing. The collected powder was packed in polyethylene pouches and stored under ambient conditions for subsequent evaluation. For reconstitution tests, 10 g of the powder was dispersed in 50 cm³ of water at 30 °C and 100 °C, after which solubility, colour, and stability of the reconstituted samples were assessed.

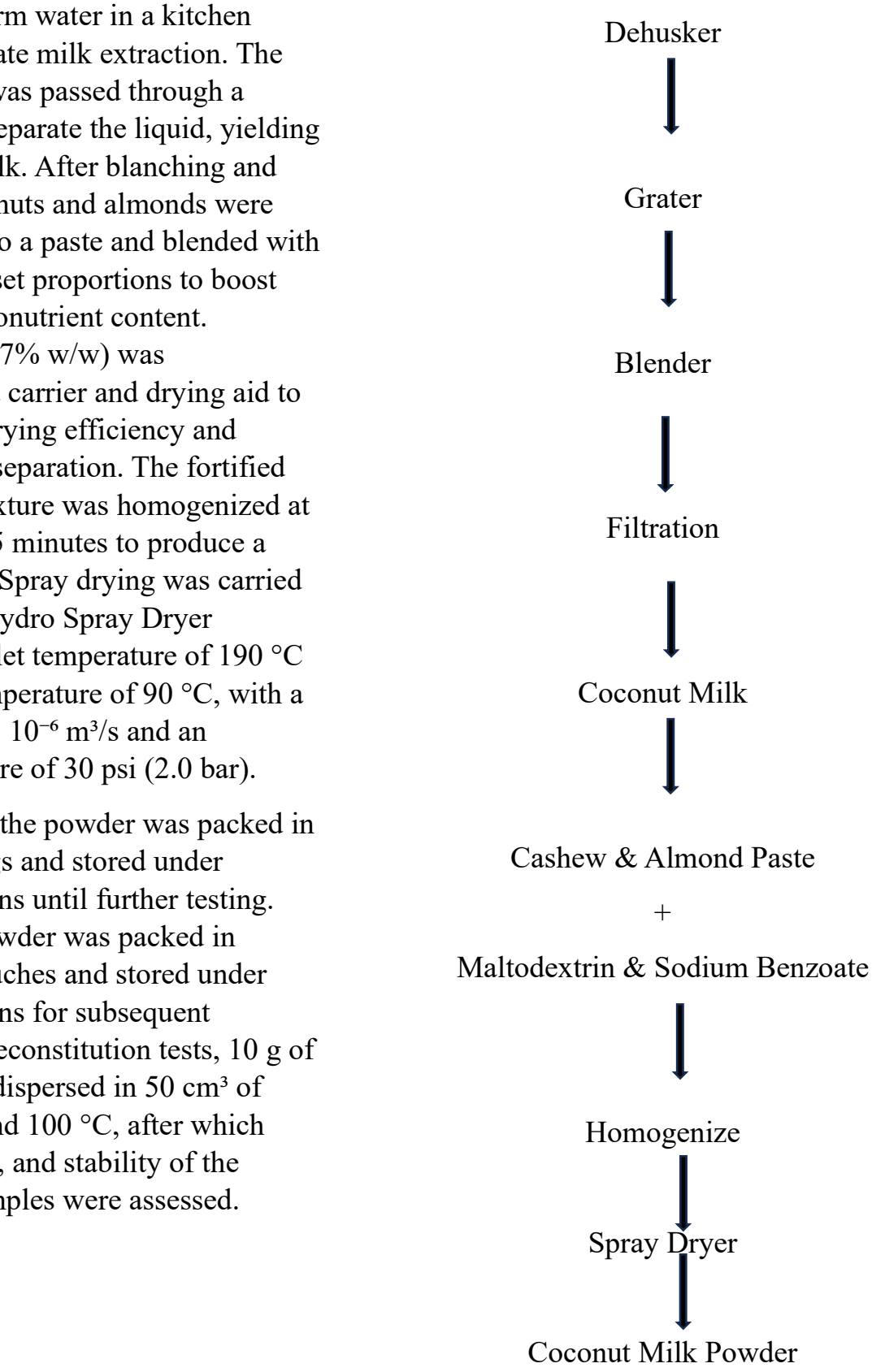

Fig. 1. Flow Chart for the production of spray dried coconut milk powder

RESULTS AND DISCUSSION

Spray drying of coconut milk enriched with cashew and almonds resulted in a fine, free-flowing powder with desirable physical properties. The addition of maltodextrin at 5–7% (w/w) proved essential in reducing stickiness during drying and preventing oil separation, which are common issues in spray drying high-fat emulsions like coconut milk.

TABLE 3

Summary of results on coconut milk powder prepared using coconut milk and maltodextrin

(Comparisons made are based on fresh coconut milk)

Sample	**% Coconut Milk**	**% Maltodextrin**	**% Almond and cashew paste**	**Solubility in water at 30°C and 100°C (Comparative)**	**Observations**	
					Powdered product	**Solution prepared by Adding water**
1	15	5	5	Very soluble	White powder, non-oily	White colour, taste closely resembles fresh coconut milk with mild nut flavour
2	15	3	7	Slightly soluble	White powder, non-oily	White colour, acceptable taste and nutty aroma
3	15	7	5	Very soluble	White powder, non-oily	White colour, acceptable taste and nutty flavour
4	13	5	7	Soluble	Creamish powder, slightly oily	Creamish solution, acceptable taste and odour
5	10	5	10	Slightly soluble	Brownish powder, slightly oily	Brownish solution, nutty taste and acceptable odour
6	7	5	13	Insoluble	Brown powder, oily	_
7	5	5	15	Insoluble	Brown powder, very oily	_

The powder obtained was white to slightly cream in colour, indicating the influence of cashew and almond incorporation. Reconstitution trials indicated that the fortified powder dissolved efficiently in water at both 30 °C and 100 °C, yielding a uniform and stable emulsion without signs of phase separation.

Solubility was significantly improved in formulations containing maltodextrin compared to those without, highlighting its role as an effective carrier and stabilizer.

The addition of cashew and almond-derived proteins and micronutrients improved the texture and sensory mouthfeel of the reconstituted powder compared to unfortified coconut milk powder.

The nutritional profile of the product was enhanced through the inclusion of cashew and almonds, which are rich in proteins, essential fatty acids, vitamins, and minerals.

TABLE 4

Summary of parameters for the

production of coconut milk powder

Basic equipment		**Spray drier**
Operating Temperature	Inlet	190℃
	outlet	90℃
Feed rate		3.3. x 10^-6 m^3/s
Compressed air pressure		2.0 bar
Additives	Coconut milk	10%-15% w/w
	Maltodextrin	5%-7% w/w

Storage studies indicated that the powder remained stable for up to three months under ambient conditions when packed in polyethylene pouches, with no rancidity, lumping, or phase separation observed. These findings are in agreement with earlier studies on the use of additives in coconut milk spray drying, but demonstrate the novelty of using plant-based fortificants such as cashews and almonds to improve both nutritional value and stability.

CONCLUSION

The present study demonstrated that coconut milk can be successfully processed into powder form with the addition of maltodextrin as a drying aid and almond–cashew paste as a protein and nutrient source. The addition of nuts enriched the nutritional value while preserving good solubility and favourable sensory qualities when included at optimal levels. Experimental trials demonstrated that a formulation comprising 15% coconut milk, 5–7% maltodextrin, and 5% nut paste resulted in a fine, white, non-oily powder characterized by high solubility and acceptable organoleptic properties.

In contrast, formulations with elevated nut paste levels exhibited increased lipid exudation, leading to agglomeration and reduced dispersibility in aqueous media. These findings suggest that nutrient-enriched coconut milk powder has strong potential as a plant-based protein supplement. Further work on large-scale production, storage stability, and consumer acceptability will help in commercializing this product successfully.

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