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Development and Characterization of Tamarind Kernel Chutney Powder for Functional and Sustainable Food Innovation

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Abstract: Increasing demand for convenience foods has contributed to the transformation of conventional items into shelf-stable, ready-to-eat product. By consider this growing demand, Tamarind kernels an underused by-product high in polyphenols and bioactive compounds, was chosen as the main component for its nutritional and water-absorbing capabilities. This research focuses on the development and characterization of a tamarind kernel-based instant chutney powder, which is a sustainable and functional alternative to perishable chutneys. The physio-chemical characterization was estimated includes bulk density, tap density, Hausner ratio, Carr's index, titratable acidity, pH, moisture content, water absorption capacity, oil absorption capacity and energy value are 0.465 g/cm³, 0.625 g/cm³, 1.34, 25.6%, 1.1%,5.9 ,5.8%,2.691g, 2.066g and 359.7kcal/100g resulted with good flowability, flavour and offering a balanced diet. Therefore, Tamarind kernel chutney powder offers a sustainable, healthy and functional food that suitable for modern dietary lifestyle.

Keywords: *Tamarind Kernel Powder ; Instant Chutney Powder; Functional Food; Balanced Diet; Nutrition ; Waste Utilization.*

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I. INTRODUCTION

A wide variety of instant food products have been developed as a result of the growing acceptance of convenience food, offering customers with quick and easy alternatives without compromising flavour or nutritional value[1]. An innovative improvement on the market are instant chutney mixes, which combine the robust, traditional flavours of handmade chutneys with the convenience of fast reconstitution and a longer shelf life. Although chutney usually has a fresh preparation, its high moisture level causes it to be very perishable and unsuitable for preservation for a long time[2].It is relevant and commercially promising to develop a dry chutney mix that preserves flavour, nutritional value, and convenience of preparation.

The tamarind (Tamarindus indica), a tropical leguminous tree that is widely grown in Southeast Asia, Africa, and India, is its most well-known product and is used in numerous culinary recipes[3].Additionally, Tamarind kernel powder(TKP) has outstanding functional qualities such emulsification, water absorption, and antioxidant activity, which makes it a viable component for the processing of food products with added value[4]**.** Tamarind Kernel powder contains polyphenolic compounds and natural antioxidants that contribute to improved shelf life and potential health benefits like anti-diabetic, anti-inflammatory, and antimicrobial effects. Utilizing Tamarind kernel powder in food applications offers a sustainable approach by encouraging the full use of agricultural produce, minimizing waste generation, and creating new revenue streams for farmers and processors[1]. It also addresses the growing demand for functional foods that offer additional health benefits in addition to basic nutrition[5]**.**

In this study, an instant chutney mix powder has been developed making use of Tamarind kernel powder as a main component. The product being developed was examined with carbohydrate, protein, fat, crude fibre, moisture content, ash content, titratable acidity, pH, density and water absorption capacity. The investigations were carried out to ensure the product's nutritional adequacy, functional quality, and storage stability. To obtain a fine, homogeneous powder with constant qualities, the formulation was standardized and constituent proportions were optimized. The developed chutney mix, containing Tamarind kernel powder, not only improves its nutritional value but also provides to the use of a widely underutilized agricultural resource. Furthermore, the ease of a quick mix product appeals to

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current customers' fast-paced lifestyles, allowing them to taste traditional flavors quickly and easily.

II. MATERIALS AND METHODS

- *Procurement of Raw Materials*

Tamarind kernel, Bengal gram, onion powder, garlic powder, dried chillies, mustard seeds, asafoetida powder and salt were sourced from the local market of Pudukkottai, Tamil Nadu.

- *Preparation of Tamarind Kernel Powder*

Tamarind kernels were dried at 130°C for 30 minutes in Hot air oven and cooled at room temperature. The Tamarind kernels were roasted and dehulled manually using mortar and pestle and then ground into fine powder in electric blender. The produced powder was stored and utilized for further processing.

- *Determination of Physical and Chemical Properties of Chutney Powder*

The physical properties such as water absorption capacity, oil absorption capacity, bulk density, tap density, Hausner ratio, compressibility ratio and angle of repose were determined. The nutritional properties include moisture content, ash content, carbohydrates, protein, fat and Energy were determined[6].

- *Preparation of Tamarind Kernel Chutney Powder*

Tamarind kernel powder is the primary ingredient providing desired flavour to the chutney. Tamarind kernel chutney powder was prepared in which the spices and other ingredients are added in different proportion. The figure 1,2 represents the image and process of chutney powder. The composition of ingredients has been given in Table 1.

Fig 1 Tamarind Kernel Chutney Powder

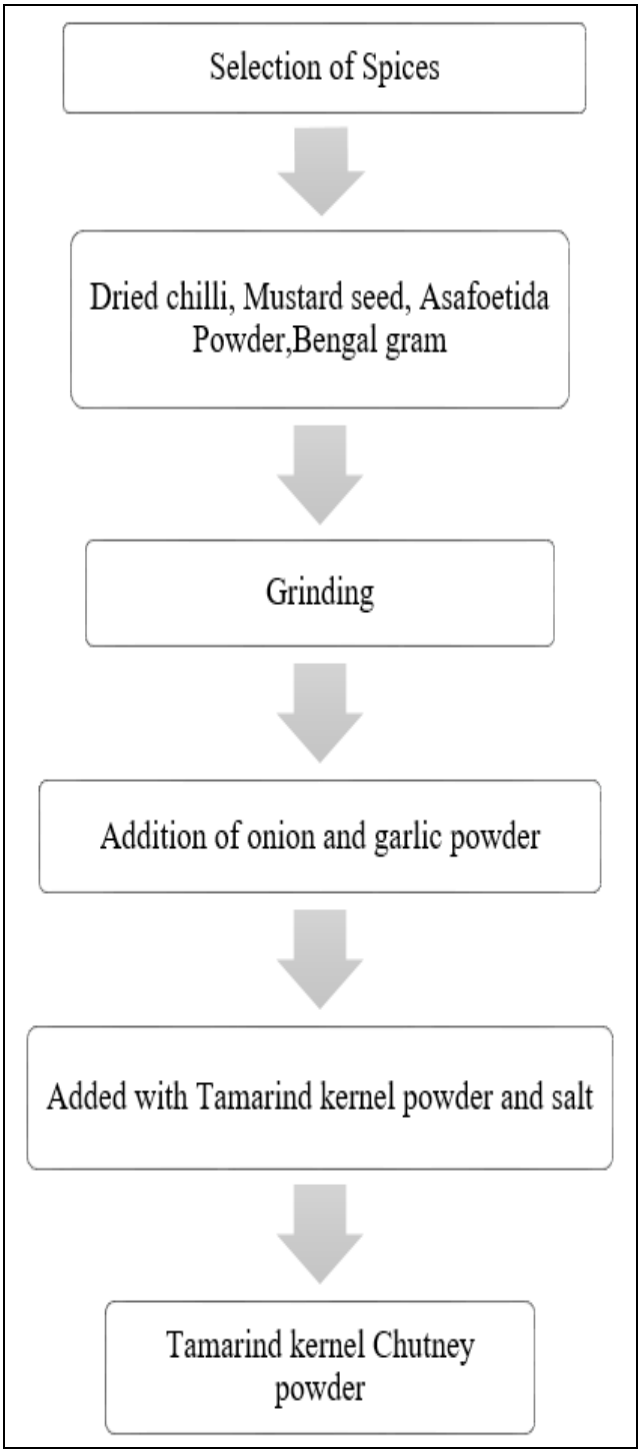

Fig 2 Process of Tamarind Kernel Chutney Powder

Table 1 Composition of Tamarind Kernel Chutney Powder

Ingredients	Scale
TKP	50g
Onion Powder	16g
Garlic Powder	10g
Bengal gram	20g
Dried chilli	12g
Mustard seeds	5g
Asafoetida Powder	0.5g
Salt	8g

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III. RESULT AND DISCUSSION

➢ *Physical Properties of Tamarind Kernel Chutney Powder*

Table 2 Physical Properties of Tamarind Kernel Chutney Powder

Properties	Value
Water absorption capacity**(g/g)	2.691±0.080
Oil absorption capacity**(g/g)	2.066±0.050
Bulk density**(g)	0.465±0.005
Tap density**(g)	0.625±0.009
Hausner ratio**	1.344±0.031
Angle of repose**	34.4° ±0.17
Carr's index**(%)	25.5±1.77
Ph**	5.9 ± 0.1
Titratable acidity**(%)	1.109 ±0.098

**Values Indicate the Average of Measurements ± SD

The physical properties of tamarind kernel chutney was represented in Table 2.Water absorption capacity of chutney powder estimated as 2.691g/g and oil absorption capacity resulted as 2.066g/g of chutney powder Tamarind kernel chutney powder sample has a bulk density of 0.465 g/cm³, that's lower than rice flours 0.914g/cm^3 [7]and Corchorus olitorius chutney powders 0.52-0.53 g/cm³[8]. This indicates that it is lower density and could be more suitable for recipes requiring low density, such as dry mixes or instant items. The tap density is 0.625 g/cm³, falling between the 0.68-0.83 g/cm³ range. The Hausner ratio of 1.344 indicates fair flowability, which is comparable to the [8] and is below acceptable limits. TKP contains carr's ratio of 25.5% is higher than wheat flour 22.17% [9] and lower than cassava flour 40.63%[10]. A carr's compressibility index indicates reduced flowability, which normally falls within the acceptable range.Angle of repose result with 34.4° lower than untreated mango kernel Powder(67°)[11]. The angle of repose is a key factor in engineering systems for handling particulate materials, influencing the design of equipment used in their processing, storage, and transport.A steep angle of repose generally suggests that the material is fine, cohesive, and does not flow easily[12]. Conversely, materials with a low angle of repose exhibit high flowability and require minimal energy for transportation [13]. Tamarind kernel chutney powder exhibits a titratable acidity of 1.109 ± 0.098%, indicating moderate acidity suitable for various food applications. Compared to tamarind leaves incorporated peanut chutney [14], which have higher acidity(3.36 ± 0.05%), tamarind kernel chutney powder provides a milder sourness, making it a balanced ingredient for enhancing flavour without overpowering acidity. Tamarind kernel chutney powder (TKCP) has a slightly higher pH value of 5.9 than tamarind leaves chutney powder [15], which normally has lower initial pH values of 3.8 to 4.0 depending on tamarind leaf content. TKCP has a softer pH profile, indicating lesser acidity. This shows that, unlike the leaf, the tamarind kernel contributes less to total acidity, perhaps leading to a more neutral taste profile and increased consumer acceptance.

➢ *Chemical Properties of Tamarind Kernel Chutney Powder*

Table 3 Chemical Properties of Tamarind Kernel Chutney Powder

Chemical Properties	Value (mean ± SD)
Energy(kcal/100g)	359.7 ± 8.3
Carbohydrates (%)	63.5 ± 1.5
Protein (%)	19.6 ± 1.2
Fat (%)	3.03 ± 0.36
Crude fibre (%)	14.8±0.6
Moisture content (%)	5.80 ± 0.25
Ash content (%)	3.5±0.3

**Values Indicate the Average of Measurements ± SD

The Chemical properties of tamarind kernel chutney powder is given in Table 3.The moisture content Tamarind kernel chutney powder reported as 5.80%.[4] reported that moisture content of seed l ranges between .9.4 to 11 per cent. This reduction in moisture content can be attributed to drying during processing, which is an essential step in the preparation of chutney powder.

Ash content indicates the amount of mineral content in the chutney powder was found to be 3.5% which shown higher ash content than tamarind kernel powder(TKP) 2.50%[16]and also [17] found that ash content of TKP was 3.2. per cent. Protein content was estimated to be 19.6 % was similarly observed in tamarind seed kernel[18] and higher than wheat flour[7].It was found that protein content was higher than common cereals like rice, wheat and found between range of protein content of pulses.

The fat content of chutney powder was estimated as 3.03% lower than fat content found in flaxseed chutney powder (25.4%). Carbohydrates resulted with 63.5g per 100g of chutney powder, similarly observed in TKP as 62.06g[16].Energy value found as 359 kcal per 100 g was similar with physiological energy value(368kcal) of TKP. It was higher than the energy value of wheat and rice [16].Also higher than the energy value of cassava flour[10].The nutritional properties of chutney powder was depicted in Table 3.

➢ Sensory Analysis of Chutney Powder

The sensory evaluation of tamarind kernel instant chutney powder was conducted by a panel comprising 6 trained and 5 semi-trained members, assessing organoleptic attributes such as appearance, texture, colour, flavour, taste, mouthfeel, and overall acceptability using a 9-point hedonic scale (where 9 indicates "like extremely" and 1 indicates "dislike extremely"). The product received consistently high scores across all sensory parameters, with colour and appearance rated the highest, indicating strong visual appeal. Flavour, taste, and texture scored between 9 and 8, suggesting a well-balanced and palatable profile. Mouthfeel, while slightly

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lower at 8, still reflected a positive response from the panel. These results confirm that the tamarind kernel chutney powder was well-accepted overall, demonstrating its sensory appeal and potential consumer acceptability. The sensory analysis results are illustrated in Figure 3.

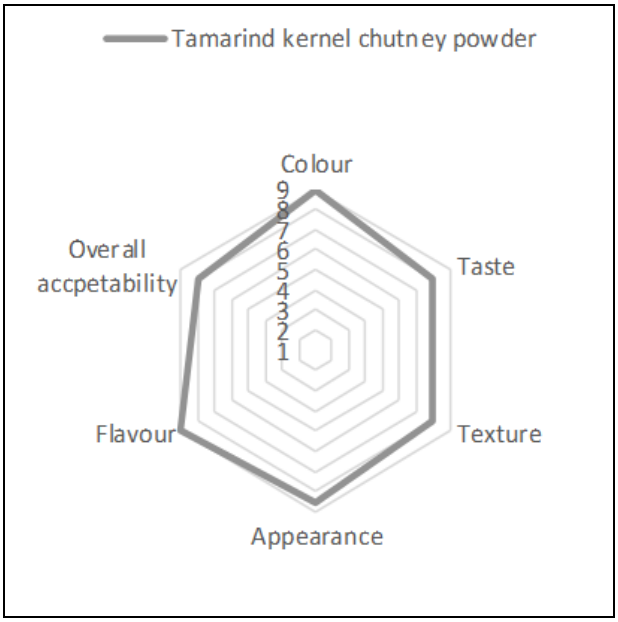

Fig 3 Sensory Analysis of Tamarind Kernel Chutney Powder

IV. CONCLUSION

The formulation of chutney powder using tamarind kernel introduces a valuable way to produce a health-oriented, eco-friendly, and shelf-stable product. This approach leverages tamarind kernel powder, a largely untapped byproduct of agro-industrial processing, to enrich the chutney with beneficial properties such as antioxidant activity and polyphenolic content. The product has positive physicochemical properties, such as superior flowability, low moisture content, and a balanced energy profile, indicating its suitability for long-term storage and simplicity of use. This formulation not only addresses the rising customer demand for accessible and healthy foods, but it also promotes environmental sustainability by lowering food processing waste. Thus, tamarind kernel-based instant chutney powder provides a potential approach for functional food creation that is consistent with modern dietary demands and circular food economy concepts.

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