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Functional properties of raw jackfruit based textured vegetable protein (TVP)

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Abstract
Textured vegetable protein or TVP is a meat substitute that mainly focuses on vegetarian population. Even though koozha, fibrous type of jackfruit (*Artocarpus heterophyllus*) is highly available it is an underutilized fruit. A textured vegetable protein (TVP) was developed based on jackfruit bulb flour, seed flour and gluten in varying proportions. Functional properties such as yield, rehydration ratio, water absorption index and appearance of the products were analyzed.

Keywords: TVP, vegetarian, koozha, functional properties, yield, rehydration ratio, water absorption index

Introduction

Jack is a tropical fruit species found in tropical, high rainfall, coastal and humid areas of the world. It belongs to family Moraceae. Scientifically known as *Artocarpus heterophyllus*, it is the favourite fruit of many, owing to its sweetness. The jackfruit tree is widely cultivated in tropical regions of India, Bangladesh, Nepal, Sri Lanka, Vietnam, Thailand, Malaysia, Indonesia and the Philippines. Jackfruit is also found across Africa, e.g., in Cameroon, Uganda, Tanzania and Mauritius, as well as throughout Brazil and Caribbean nations such as Jamaica. However, India is considered to be the native of jack fruit. In our country, the trees are found distributed in southern states like Kerala, Tamil Nadu, Karnataka, Goa, coastal Maharashtra and other states like, Assam, Bihar, Tripura, Uttar Pradesh and foothills of Himalayas.

The jack fruit trees naturally exist in the farm lands and in secondary forest regions. They produce fruits only with the blessings of nature and there is no human intervention. Therefore, by default, they are organic produce. While fresh consumption of jack bulbs is limited, processing and value addition is also negligible. In many cuisines, immature and mature jack fruits are relished in various forms of dishes. But the half ripened and ripened fruits are mostly fed to cattle. It has been reported to increase milk yield of cattle. Thus, the full potential of jack fruit has not been realised by the local folk of certain regions in our country. The huge post harvest loss of the fruits paves way for loss of nutrients in the fruit that would otherwise nourish the consumers. Thus, jack fruit is a commercially unexploited fruit and there exists no awareness among the farmers about its potential.

The successful utilization of seed flour and bulb flour as a food ingredient and its blending with wheat gluten depends on functional characteristics, which it would impart to the end products. This analysis would provide useful information towards effective utilization of the product.

Materials and Methods

Development of jackfruit based Textured Vegetable Product (TVP)

Eleven formulations of jackfruit based TVP using jackfruit bulb flour (JFBF) and seed flour (JFSF) along with gluten (G), yeast and soya flour (in constant proportion) were processed to form TVP. The quality analyses of the treatments were undertaken using standard procedures.

Table 1: Treatments for the development of TVP

S. No.	Treatment	G	JFBF	JFSF
1	P_1	50	20	30
2	P_2	50	30	20
3	P_3	50	10	40
4	P_4	50	25	25
5	P_5	50	-	50
6	P_6	50	50	-
7	P_7	70	20	10
8	P_8	70	10	20
9	P_9	70	15	15
10	P_{10}	70	-	30
11	P_{11}	70	30	-

(G - Gluten, JFBF – Jackfruit bulb flour, JFSF- Jackfruit seed flour)

Functional quality analysis of TVP

Functional properties describes how ingredients behave during preparation and cooking, how they affect the finished food product in terms of how it looks, tastes and feels. Functional properties are the fundamental physico- chemical properties that reflects the complex interaction between the composition, structure, molecular conformation and physico- chemical properties of food components together with the nature of environment in which these are associated and measured (Kaur and Singh, 2006) [7]. Functional qualities such as yield, appearance, and rehydration ratio and water absorption index were studied.

Yield of TVP

Estimation of yield percent in food processing will be useful in determining cost of product. The yield per cent of the TVP was calculated on dry weight basis. To determine the yield per cent for TVP the following formula was used.

$$\text{Yield ratio} = \frac{\text{Weight of TVP obtained}}{\text{Weight of raw ingredients}} \times 100$$

Appearance

Appearance is the criteria for the desirability of any food product. The best treatment was identified by analyzing the scores of Overall visual quality (OVQ), using a 1-9 point scale where, 9 refers to excellent appearance, 7 to good, 5 to fair (limit of markrtability), 3 to fair useable but not saleable and 1 to unusable, this evaluation was conducted by a panel comprising of 10 members (Yuan *et al*., 2010) [15].

Rehydration Ratio

About 10 g of sample was mixed with 100 ml of distilled water and stirred for 5 minutes. The contents were filtered using a filter paper. The rehydrated sample was weighed (Ranganna, 1995).

$$\text{Rehydration Ratio} = \frac{\text{Weight of sample}}{\text{Drained weight of sample}}$$

Water Absorption Index (WAI)

Water absorption index is the quantity of water absorbed by a known quantity of the food sample. Water absorption index was measured by the method of Beuchat (1997) [3]. Known volume of sample (1 g) and water (10 ml) were mixed in a centrifuged tube. The suspension was allowed to stand at room temperature. It was then centrifuged for 30 minutes. The volume of drained water and sediment was measured.

$$\text{Water Absorption Index} = \frac{\text{Weight of water absorbed (g)}}{\text{Weight of dry flour (g)}} \times 100$$

Results

Yield of TVP

Estimation of yield percent in food processing will be useful in determining cost of product. The yield per cent of the TVP was calculated on dry weight basis. Drying removes moisture, as a result the product shrinks and decreases in size and weight, thus requiring less space for storage. Mostly foods lose volume or weight as they are processed. Yield of dried products are directly related to how much water is in the original product. Yield ratio of the different combinations were analysed and the results are presented in the Table 3. Yield ratio of different treatments ranged from 0.650 – 0.770 per cent. Results further revealed that P_3 having G: JFBF: JFSF in the ratio of 50:10:40 had the highest value (0.770). The lowest value was obtained by P_9 (0.650). Yield ratio obtained for other treatments were P_1 (0.670), P_2 (0.670), P_4 (0.746), P_5 (0.723), P_6 (0.693), P_7 (0.750), P_8 (0.723), P_{10} (0.670), P_{11} (0.683) respectively.

Appearance

The appearance parameter increases the appeal of a product.
The mean rank value of scores allotted by the panel members for overall visual quality was evaluated. TVP developed from all the 11 treatments were rated by panel members. This total perception is built up from all the visual sensations experienced when a product is viewed on the shelf or as it is being prepared or when it is presented on the plate, and all three situations are extremely important to the consumer and hence to the processor (Hutchings, 1977) [5]. Overall visual quality (OVQ) scores for raw TVP revealed that P_7 scored the highest mean rank value (88.55) and P_4 scored the lowest mean rank value (17.60). The values were found to be significantly different as revealed by the CD value (Table 2.). Many individual factors contribute to the total perception of the appearance of a food product.

Table 2: OVQ scores obtained for various treatments

S. No.	Treatment	OVQ Scores
1	P_1	50
2	P_2	38.50
3	P_3	35.55
4	P_4	17.60
5	P_5	19.90
6	P_6	35.55
7	P_7	88.55
8	P_8	85.70
9	P_9	70.10
10	P_{10}	85.70
11	P_{11}	83.35
CD (0.05)		18.31

Rehydration Ratio

Rehydration is an essential parameter to analyze dried products. A high value of rehydration ratio means the dried product has a good quality because the pores allow water to reenter the cells (Noomhorm, 2007) [11]. Rehydration ratio was highest for the treatments P_9, P_{10}, P_{11} (0.456) followed by P_7 and P_8 (0.423). Treatment P_2 and P_3 (0.413) had the least rehydration ratio. The rehydration ratio obtained for other treatments were as follows P_1 (0.417), P_4 (0.416), P_5 (0.416), P_6 (0.415). Rehydration is a process which is aimed at restoring the properties of a raw material when the dried material comes in contact with water (An *et al*., 2013) [2]. Rehydration of food materials is often carried out by soaking the dried material in water (Pascual *et al*., 2005) [12]. Rehydration may be regarded as a measure of the injury to the material which occurs as a result of drying and treatment that precedes dehydration (McMinn and Magee, 1997) [10]. The extent of rehydration depends on the degree of structural and cellular disruption (Krokida and Kouris, 2003) [8]. Jayaraman *et al.* (1990) [6] noticed irreversible cellular rupture and dislocation, which led to the loss of integrity and consequently, a dense structure of collapsed, greatly shrunken capillaries with reduced hydrophilic properties, as seen by the inability to imbibe enough water to fully rehydrate. The rehydration characteristics of dried food materials are used as a quality parameter to show whether physical and chemical changes occurred during the drying process due to process conditions, pretreatments and sample composition (Lewicki, 1998) [9].

Water Absorption Index (WAI)

Water absorption index, an indicator of the ability of flour to absorb water, it depends on the availability of hydrophilic groups which bind water molecules and on the gel forming capacity of macromolecules. Nevertheless highest WAI denotes the excellent binding capacity of ingredients. Water absorption is the increase in weight of dried products after cooking in boiling water according to their cooking time (Purwandari *et al*., 2014) [13]. Water absorption index of varying treatments were represented in the Table 3. It ranged from 104.33- 140.66 per cent. Water absorption of TVP was found to be higher in P_5 (140.66) treatment which contained more amount of seed flour. The treatment P_6 (138.33) was on par with P_5 which contained more amount of bulb flour. In these treatments it was seen that the increase in concentration of bulb flour and seed flour increased water absorption. Abraham and Jayamuthunagai (2014) [1] reported that jackfruit seed flour has a good ability to bind water. Several authors reported that the water absorption capacity depends on the behaviour of the protein denaturation, the function of the amylase/ amylopectin ratio as well as the chain length distribution of amylopectin (Kober *et al*., 2007) [11].

Table 3: Functional properties of various treatments

S. No.	Treatment	Yield	Rehydration Ratio	Water Absorption Index
1	P_1	0.670	0.417	111.33
2	P_2	0.670	0.413	120.00
3	P_3	0.770	0.413	121.66
4	P_4	0.746	0.416	131.33
5	P_5	0.723	0.416	140.66
6	P_6	0.693	0.415	138.33
7	P_7	0.750	0.423	104.33
8	P_8	0.723	0.423	109.33
9	P_9	0.650	0.456	105.33
10	P_{10}	0.670	0.456	126.33
11	P_{11}	0.683	0.456	123.66
CD (0.05)		0.010	0.008	1.068

Conclusion

The present study reveals that jackfruit seed flour, jackfruit bulb flour along with gluten has a great potential in new food formulations. The fruit is commonly consumed in its fresh state or minimally processed form. Due to the increasing trend of consumer demands towards ready-to-eat, healthy products, jackfruit can be one of the potential sources for the production of such value-added products. Variety can be imparted to dishes by incorporating flours of fruits.

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