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Hog Plum (*Spondias mombin*) Based RTE Products: Development, Quality Assessment and Shelf-Life Studies

H. Sindhu[1], Roopa B. Patil[2], K. G. Vijayalaxmi[3],
Babu Rajaram Mohan Ray[4] and Manjunath Swamy[5]
[1,2&3]Department of Food Science and Nutrition, [4]Department of Food Processing and Engineering,
[5]Department of Horticulture, University of Agricultural Sciences, GKVK, Bangalore - 560 065
e-Mail : sindhukanda27@gmail.com

Authors Contribution

H. Sindhu :
Investigation, curation, data collection and draft manuscript preparation

Roopa B. Patil :
Supervision, results, interpretation and editing manuscript

K. G. Vijayalaxmi :
Babu Rajaram Mohan Ray& Manjunath Swamy :
Guidance, supported for laboratory work and reviewed article

Corresponding Author :
H. Sindhu

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Abstract

Hog-plum *(Spondias mombin*) is an underutilized less expensive fruit belongs to the family of Anacardiaceae and it has nutritional and therapeutic value, making it an important component of a balanced diet. The present study was carried out to develop and evaluate of RTE Hog Plum products with the aim of enhancing their nutritional value. The proximate composition per 100g of Hog Plum powder revealed that it contained 8.37 ± 0.36 per cent moisture, 1.47 ± 0.12g protein 0.27 ± 0.05g fat. 0.61 ± 0.05g ash, 13.80 ± 0.03g carbohydrate and 63.51 ± 0.03 Kcal energy. Hog Plum contained 47.33mg for vitamin C and 26.19mg for polyphenol. Ready-To- Eat products *Chutney* powder, pickle and marmalade were developed using different variations of Hog Plum at 25, 50, 75 and 100 per cent. Among the variations,chutney powder and pickle incorporated with 100 per cent Hog Plum were found to be highly acceptable with mean sensory scores of 8.7 and 8.3 respectively. Where as 75 per cent incorporated Hog Plum marmalade scored best with a mean score of 8.3. The proximate composition of RTE Hog Plum products revealed *Chutney* powder had the highest protein (8.82g), fat (7.70g) and ash (1.80g) per 100g, while marmalade contained more crude fiber (18.8g) and carbohydrates (28g). The Shelf life was assessed interms of moisture, peroxide value, ascorbic acid, TSS and pH, sensory and microbial load. The Hog plum RTE products were safe for consumption for 90 days when stored in multi-layered polypropylene (*chutney* powder) covers and in airtight glass jars (pickle and marmalade) at ambient temperature. Thus, one can exploit the health benefits of Hog plum by processing and value addition.

Keywords : Hog plum, Ready-to-eat product (RTE), Nutritional composition, Sensory evaluation, Shelf-life studies

Importance of fruit in human diet is well recognized. Many people suffering with malnutrition due to inadequate and imbalance diet. The daily per capita fruit requirement may not be enough due to various reasons. Among different fruits one of the less expensive is Hog-plum (*Spondias mombin*). Hog-plum is an underutilized fruit belongs to the family of Anacardiaceae and its scientific name is *Spondias mombin*. It is used as food and medicine since time immemorial. Indian Hog Plum are found to grow as wild or cultivated up to 1500 m altitude, throughout the tropical Indian subcontinent, Andaman Islands, Sri Lanka, Myanmar, Thailand, Malaysia, China and also widely distributed in the Philippines. In India, these plants are found growing very well in the tropical and Himalaya's regions, but it is seldom found in western, although there are reported of its growing wild in the forest of Karnataka. Recently, attempt has been made to introduce this species to the semiarid conditions of Anand, Gujarat (Rymbai *et al.,* 2016).



Despite its relatively low cost, hog plum provides substantial nutritional and therapeutic value, making it an important yet often overlooked component of a balanced diet. Hog plum, a medicinal plant and fruit crop has several common names; it is called as Amra in Hindi, Hog plum in English, Adavimamidi in Telugu, Kincam in Tamil and Ambatte kayi in Kannada (Mondal *et al.,* 2021). Hog plums are rich in antioxidants *viz.,* ascorbic acid (22.10mg/100gpulp) and total phenolics (29.19mg/100gpulp). The free radical scavenging activity against the 2,2-dipheny l-1-picrylhydrazyl (DPPH) radical was at the level of 15.09 per cent, which strengthens the immune system, protects against heart disease and stimulates the production of collagen which keep the body healthy (Nwidu *et al*., 2017).

A significant portion of these valuable fruits are lost, wasted and damaged due to inadequate storage conditions and problems with marketing, preservation, and transportation. This is particularly valid during the busiest season of the year. In order to reduce waste and ensure that the fruit supplier is paid fairly, preservation is necessary (Akther, 2020). In spite of having nutritional and medicinal values of Indian Hog plum (*Spondias pinnata Linn*.), the crop has not been properly utilized. For long term preservation, processing is considered to be the best method. The underutilized crops could also have an important role to play as new promising crops due to their consistent use in lesser common farming situations and subsistence agriculture practiced by poor farming households (Bhuiyan, 2012). Due to poor keeping quality and difficulties of transportation, preservation and marketing facilities, a huge quantity of these valuable fruits is being damaged, spoiled and wasted specially during the peak season. To reduce the wastage and to get a reasonable price by the producer of this fruit, preservation is necessary. It is possible to increase the utility of this fruit. Hog-plums are usually eaten raw and can be used for preparation of pickles, chutney and processed food (Akther, 2020). It is apparent that research work needs to be undertaken for processing and preservation of hog-plum by using locally available machineries and thus low-level technology involving minimal capital investment.

Hence, the present investigation was aimed to develop and evaluate RTE products prepared from Hog Plum, with the aim of enhancing their nutritional value while maintaining sensory acceptability. The study explores the potential of Hog Plum as a functional ingredient in ready to eat foods such as Hog Plum *chutney* powder, Hog Plum pickle and Hog Plum marmalade to provide insight into its impact on the nutritional, sensory attributes of the developed products.

Material and Methods

Procurement of Raw Materials

The fresh hog plum raw fruits were collected from the Department of Horticulture, UAS, GKVK, Bengaluru and other ingredients used for development of value-added products were procured from local market Bengaluru. The collected fruits were thoroughly washed in running tap water to remove the adhering dust and dirt, the washed fruits were air dried, packed in High-density polyethylene (HDPE) bags and stored at freezer for further studies

Development of RTE Hog Plum Based Products

The RTE Hog Plum products were carefully developed and standardized. These include Hog plum *chutney* powder, pickle and marmalade. Hog plum *chutney* powder was prepared by incorporating Hog plum powder with mango powder at 25, 50, 75 and 100 per cent (Fig. 2). Hog plum pickle was prepared by incorporating dehydrated Hog plum pieces with dehydrated mango pieces at 25, 50, 75 and 100 per cent (Fig. 4) and Hog plum marmalade was prepared by incorporating fresh Hog plum with orange at 25, 50, 75 and 100 per cent (Fig. 6). The control used for the preparation of RTE Hog Plum *chutney* powder, Hog Plum pickle and Hog Plum marmalade were mango chutney powder, mango pickle and orange marmalade respectively. The standardized recipes used for the preparation of RTE Hog plum products Hog plum chutney powder, pickle and marmalade are presented in Fig. 1, Fig. 3 and Fig. 5.

Sensory Evaluation of Developed Products

All the developed RTE Hog plum products were organoleptically evaluated using 9-point hedonic scale (Ranganna, 1986) by 25 semi-trained panel

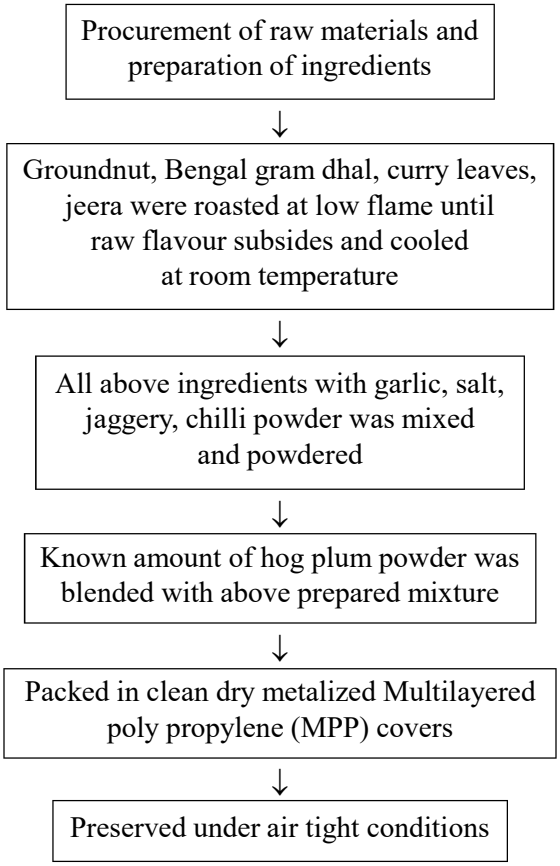

Fig. 1 : Preparation of RTE Hog Plum *chutney* powder

Fig. 2 : RTE Hog Plum *chutney* powder

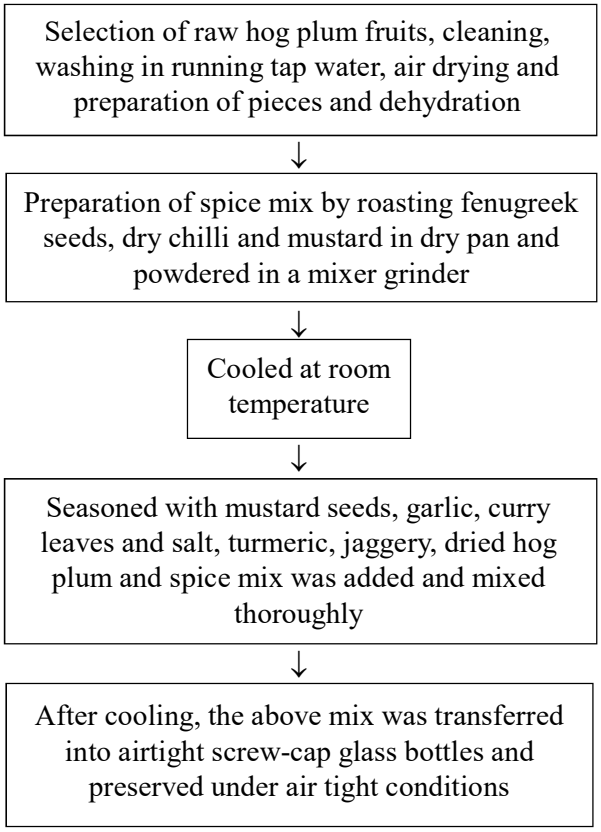

Fig. 3 : Preparation of RTE Hog Plum pickle

members for the evaluation of sensory attributes such as for the appearance, color, texture, taste, flavour and overall acceptability.

Nutrient Composition of Best Accepted RTE Hog Plum Products

Analysis of Hog plum was done by following the AOAC (1980) official protocols. Moisture was determined from sample weight loss after drying at 110 °C for 4 h. Protein (g) content was determined by Kjeldahl method. The Soxhlet method was used for total fat(g) determination. Crude fiber was estimated by treatment of sample first with acid and subsequently with alkali. The loss in weight was the crude fibre content. Carbohydrate and energy by difference method and ash by muffle furnace, All samples were analyzed in triplicates. Nutrient composition of the best accepted developed products was computed based on the nutritional composition table of the ingredients (Gopalan *et al*., 2009 and Longvah *et al*., 2017).

Shelf-Life Study of the Developed Products

The best accepted Hog plum *chutney* powder was stored in Multi layered polypropylene (MPP) cover

Fig. 4 : RTE Hog Plum pickle

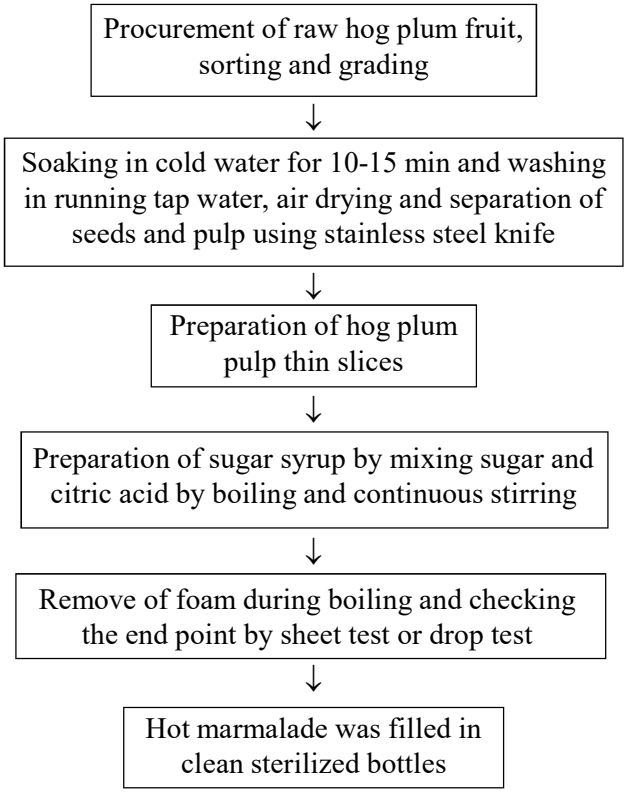

Fig. 5 : Preparation of RTE Hog Plum marmalade

under ambient conditions for a period of 90 days. The stored samples were analyzed for moisture, peroxide value, ascorbic acid, sensory characteristics and microbial load and tested periodically from initial to 90th day at the interval of 30 days.

Hog plum pickle and marmalade were stored in airtight screw-cap glass jars under ambient conditions for 90 days. The stored samples were analyzed for moisture, TSS, ascorbic acid, sensory characteristics and microbial load and tested periodically from initial to 90th day at the interval of 30 days.

Statistical Analysis

Means of triplicates of the research data obtained were assessed using Complete Randomized Design (CRD) with the help of Microsoft excel (2010) and OPStat (14.139.252) software. One-way analysis of variance (ANOVA) was used to analyse the sensory scores to find the significant difference between the different characteristics and treatments of developed products ($p< 0.05$) (Kumari and Gupta, 2024).

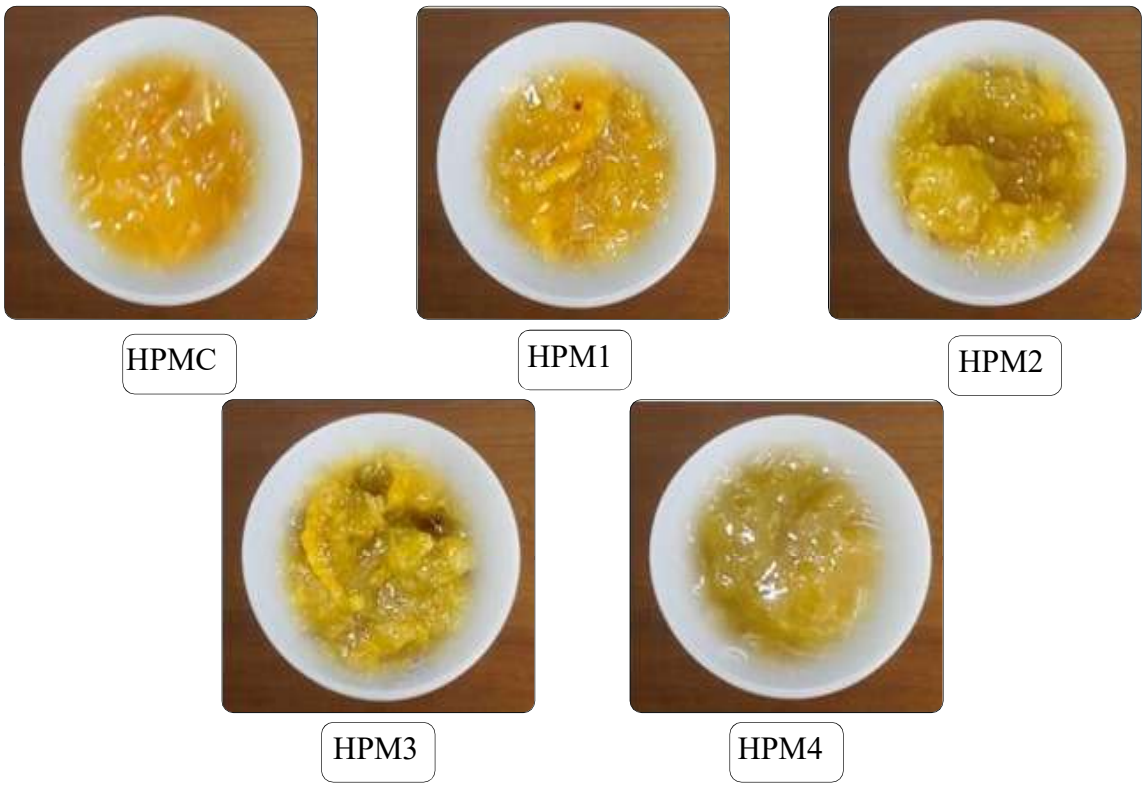

Fig. 6 : RTE Hog Plum marmalade

Results and Discussion

Mean Sensory Scores of RTE Hog Plum Products

Chutney powder, a versatile spice mix, is a key component of Indian cuisine and has gained global popularity for its robust, tangy and spicy flavors. In this study, chutney powder was standardized using Hog Plum powder blended with mango powder at 25 per cent (HPCP1), 50 per cent (HPCP2), 75 per cent (HPCP3) and 100 per cent (HPCP4), while the control (HPCPC) was made with 100 per cent mango powder. Sensory evaluation (Table 1 and Fig. 7) showed that Hog Plum Chutney Powder (HPCP4) showed significantly highest for appearance (8.7), colour (8.4), texture (8.6), flavour (8.6), taste (8.6) and overall acceptability (8.7) among the variations. Netravati (2013) found that flax seed chutney powder with 50 per cent flax seed achieved the highest overall acceptability (7.67), while 100 per cent flaxseed scored 7.33, highlighting the sensory benefits of partial substitution.

In India, pickles ('achaar') are cherished condiments made by preserving fruits, vegetables or meats in spices, salt & oil, offering sweet, sour or spicy flavours with a long shelf life. This study standardized pickle by incorporating dehydrated Hog Plum with dehydrated mango pieces at

Table 1

Mean sensory scores of RTE Hog Plum *chutney* powder

Treatments	Variations		Appearance	Colour	Texture	Flavour	Taste	OAA
	Mango powder (%)	Hog Plum powder (%)						
HPCPC	100	0	7.4	6.8	7.4	8.0	7.4	8.1
HPCP1	75	25	7.8	8.1	7.9	7.4	7.6	7.4
HPCP2	50	50	7.5	7.8	7.7	7.8	8.1	7.5
HPCP3	25	75	7.5	8.0	8.6	8.6	7.6	8.6
HPCP4	0	100	8.7	8.4	8.6	8.6	8.6	8.7
		F value	*	*	NS	*	*	*
		CD	0.16	0.22	0.17	0.19	0.15	0.23
		SEm±	0.34	0.33	0.35	-	0.32	0.34

Note : * p<0.05, HPCPC – control *chutney* powder, HPCP – Hog Plum *chutney* powder, OAA- Overall acceptability

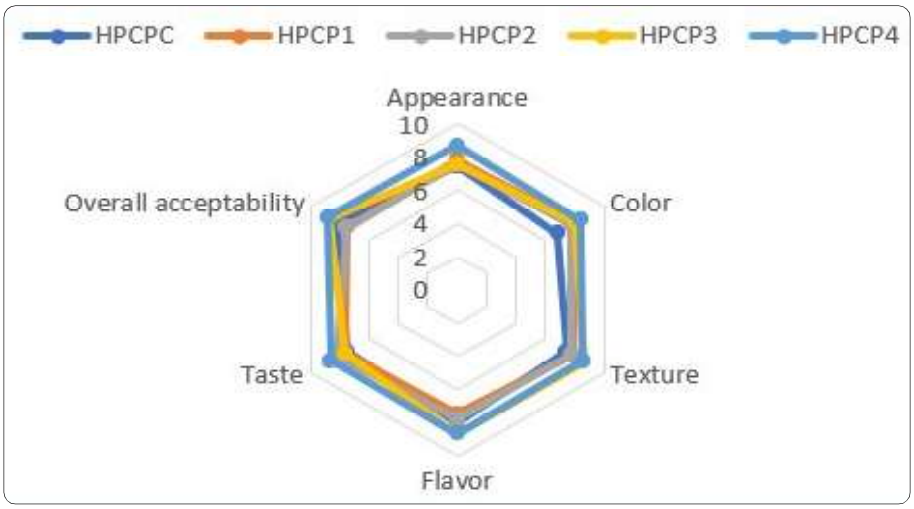

Fig. 7 : Mean sensory scores of RTE Hog Plum *chutney* powder

25 per cent (HPP1), 50 per cent (HPP2), 75 per cent (HPP3) and 100 per cent (HPP4), while the control (HPPC) is prepared by using 100 per cent dehydrated mango pieces. Sensory evaluation of ready-to-eat pickle prepared with dehydrated Hog Plum and mango pieces (Table 2 and Fig. 8) showed that the 100 per cent Hog Plum variation (HPP4) had highest scores for appearance (8.3), colour (8.6), texture (8.2), flavour (8.4), taste (8.4) and overall acceptability (8.3). The 25 per cent Hog Plum variation (HPP1) had the lowest scores for appearance, colour, texture, flavour, taste and OAA (7.1, 7.2, 6.4, 6.9, 6.0 and 7.1, respectively). All sensory differences among variations were statistically significant ($p<0.05$). Al-Azzawi and Al-Abdullah (2019) reported that pickles preserved with lemon juice achieved the highest overall acceptability score (8.45), while those using vinegar

TABLE 2

Mean sensory scores of RTE Hog Plum pickle

Treatments	Variations		Appearance	Colour	Texture	Flavour	Taste	OAA
	Dehydrated mango pieces (%)	Dehydrated Hog Plum pieces(%)						
HPPC	100	0	7.2	7.3	7.4	8.1	7.3	7.5
HPP1	75	25	7.1	7.2	6.4	6.9	6.0	7.1
HPP2	50	50	7.4	7.3	7.2	7.3	7.8	7.3
HPP3	25	75	7.3	8.4	8.0	8.2	7.5	7.8
HPP4	0	100	8.3	8.6	8.2	8.4	8.4	8.3
		F value	*	*	*	*	*	*
		CD	0.33	0.3	0.33	0.35	0.36	0.34
		SEm±	0.18	0.24	0.19	0.25	0.27	0.28

Note : * $p<0.05$, HPPC – Control pickle, HPP – Hog Plum pickle, OAA- Overall acceptability

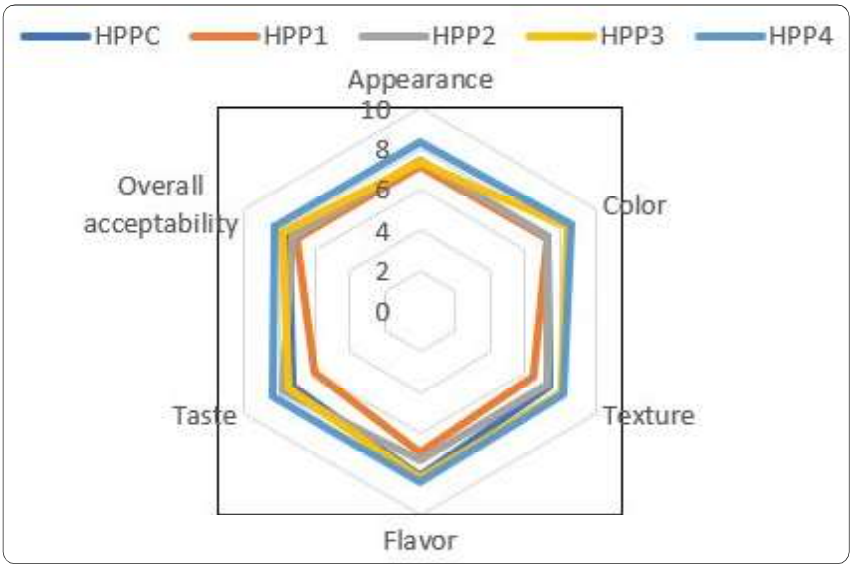

Fig. 8 : Mean sensory scores of RTE Hog Plum pickle

scored lower (6.90) due to a stronger acidic taste and less appealing texture.

Marmalade, a tangy and vibrant fruit preserve, is valued for its texture, taste and versatility. Typically made by boiling fruit pulp with sugar and water, it combines sweetness and slight bitterness, making it a popular spread or dessert ingredient. The sensory evaluation of ready-to-eat marmalade (Table 3 and Fig. 9) standardized using fresh Hog Plum incorporated with orange at 25 per cent Hog Plum (HPM1), 50 per cent Hog Plum (HPM2), 75 per cent Hog Plum (HPM3) and 100 per cent Hog Plum (HPM4) and control was prepared from 100 per cent orange (HPMC), revealed statistically significant differences ($p < 0.05$) among all sensory attributes. Among the variations, the 75 per cent Hog Plum marmalade (HPM3) received the significantly highest scores for appearance (8.1), color (8.2), texture (8.0), flavor (8.4), taste (8.7) and overall acceptability (8.3). Conversely, the 25 per cent Hog Plum marmalade (HPM1) recorded the significantly lowest scores, ranging from 6.3 to 7.4 across the evaluated attributes. The similar observation was found by Veena *et al.* (2011). Similarly, Deshmukh *et al.* (2021) found that blending 40 per cent mandarin with 5 per cent lime in citrus marmalade achieved the highest sensory score

Table 3

Mean sensory scores of RTE Hog Plum marmalade

Treatments	Variations		Appearance	Colour	Texture	Flavour	Taste	OAA
	Fresh Hog Plum (%)	Fresh Hog Plum (%)						
HPMC	100	0	8.0	7.2	7.3	8.0	7.6	8.1
HPM1	75	25	7.4	6.3	6.6	7.3	7.2	6.5
HPM2	50	50	7.8	6.6	7.8	7.7	8.1	7.5
HPM3	25	75	8.1	8.2	8.0	8.4	8.7	8.3
HPM4	0	100	8	8	7.4	8.2	8.4	8.2
		F value	*	*	*	*	*	*
		CD	0.33	0.33	0.33	0.35	0.34	0.34
		SEm±	0.13	0.20	0.21	0.18	0.23	0.19

Note : * p<0.05,HPMC – Control marmalade, HPM – Hog Plum marmalade, OAA- Overall acceptability

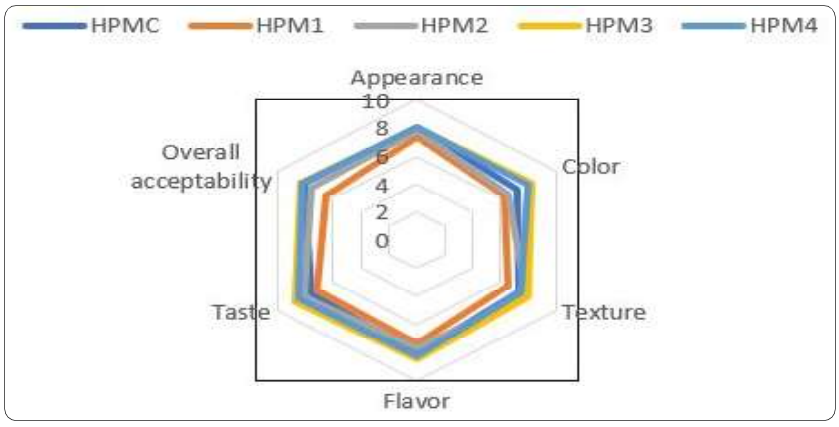

Fig. 9 : Mean sensory scores of RTE Hog Plum marmalade

(8.5), while higher lime content (10%) lowered acceptability (6.9) due to excessive tartness, emphasizing the role of balanced fruit blends in enhancing sensory and nutritional quality.

Proximate Composition of Hog Plum Powder and Best Accepted Hog Plum RTE Products

Proximate and anti-oxidant composition of Hog Plum powder is depicted in Table 4, giving an overview of its nutrient content and potential health benefits. Proximate composition of Hog plum powder revealed that moisture, protein and fat content was 8.37 ± 0.36%, 1.47 ± 0.12g and 0.27 ± 0.05g per 100g respectively. Hog plum had ash content 0.61 ± 0.05g and crude fiber content of 31.18 ± 0.89g indicating that Hog Plum powder is an excellent source of dietary fiber, which is beneficial for digestive health and can aid in regulating blood sugar and cholesterol levels. Carbohydrate and energy content was 13.80 ± 0.03g and 63.51 ± 0.03 kcal per 100g respectively. The vitamin C and polyphenol content of Hog plum found to contain was measured at 47.33 ± 0.92 mg and 26.19 ± 0.23 mg/100g respectively, demonstrating that it is a good source of these important antioxidants, which supports immune function and skin health. Moura *et al*. (2015) analyzed nutraceutical and the rapeutic yellow mombin fruit.

TABLE 4

Proximate and anti-oxidant composition of Hog Plum powder (per 100g)

Nutrients	Values
Moisture (%)	8.37 ± 0.36
Protein (g)	1.47 ± 0.12
Fat (g)	0.27 ± 0.05
Ash (g)	0.61 ± 0.05
Crudefiber (g)	31.18 ± 0.89
Carbohydrate * (g)	13.80 ± 0.03
Energy ** (Kcal)	63.51 ± 0.03
Vitamin C (mg)	47.33 ± 0.92
Polyphenols (mg)	26.19 ± 0.23

*Carbohydrate by difference method and
**Energy by computation

The study found that the moisture content of the fruit is 90.3 per cent, fat is 0.30 per cent, total carbohydrates range between 16.30-23.54 per cent and protein content is between 0.50-0.80 per cent.

The proximate composition of the best-accepted RTE Hog Plum products (Table 5) highlights their nutritional profiles per 100g. Hog Plum chutney powder (HPCP4) showed slightly lower moisture (8.3%) than the control (8.8%) but had higher protein (8.82g), fat (7.7g), total ash (1.8g), crude fiber (16.75g) and carbohydrate (14.7g) and energy value (164 Kcal) compared to the control. Hog Plum pickle (HPP4) showed the same moisture content as the control (40.6%) but exhibited higher protein (2.5g), fat (2.1g), ash (1.5g) and crude fiber (24.1g), carbohydrate content (13.5g) and energy (77.3 Kcal) compared to control pickle. Hog Plum marmalade (HPM3) had notably lower moisture (51.4%) compared to the control (75.4%) but displayed slightly higher protein (1.0g), ash (0.4g) and crude fiber (18.8g), carbohydrate content (28.0g) and energy value (117 Kcal) compared to the control. These results underscore the nutritional enhancement achieved by incorporating higher levels of Hog Plum in these products. Sharma *et al*. (2019) reported that raw mango *chutney* powder contained 6.5 per cent moisture, 5.8 per cent protein, 2.3 per cent fat, 82.4 per cent carbohydrates and 3.0 per cent ash, highlighting its nutritional value as a potential value-added product. Al-Azzawi and Al-Abdullah (2019) found processed pickles to have 85-90 per cent moisture, 2.5-5.0 per cent ash and low fat (0.5-1.0%), indicating their low caloric density. Estaji *et al*. (2020) reported that black plum peel marmalade had 60.25 per cent moisture, 0.60-0.80 per cent ash, 0.73 per cent protein and 0.25 per cent fat, highlighting its low-fat, moderate-protein profile as a healthy food option.

Shelf-life Study of the RTE Hog Plum Based Developed Products

Mean Sensory Scores of RTE Hog Plum products on Storage

Mean sensory scores of RTE Hog Plum products on storage is presented in Table 6. Hog Plum chutney powder (HPCP4) and control chutney powder

(HPCPC) were stored in multi-layered polypropylene (MPP) at ambient temperature (33 ± 2°C) for 90 days. Results revealed that mean sensory scores for appearance (8.2 to 7.3), colour (8.7 to 7.1), texture (8.6 to 7.4), flavor (8.5 to 7.2), taste (8.6 to 7.2) and overall acceptability (8.4 to 7.5) in control chutney powder decreased significantly ($p>0.05$) from initial to 90th day of storage. Where as in Hog Plum chutney powder, scores for appearance (8.1 to 7.1), colour (8.1 to 7.4) and texture (8.0 to 7.1) decreased significantly, while flavor (7.8 to 7.3), taste (7.7 to 7.4) and overall acceptability (7.8 to 7.4) showed non-significant decreases. Similarly, Rao *et al*. (2008) found that raw mango chutney powder retained good sensory qualities over three months, scoring 8.5 for flavor and 8.3 for overall acceptability.

Hog Plum pickle (HPP4) and control pickle (HPPC) were stored in screw-cap glass jars at room temperature (33 ± 2°C) and monitored daily for visual changes, with monthly sensory evaluations over 90 days. Sensory scores significantly decreased ($p>0.05$) during storage. For the control pickle, scores for appearance, colour, texture, flavor, taste and overall acceptability declined from 8.3, 8.1, 8.4, 8.3, 8.7 and 8.5 to 7.5, 7.5, 7.1, 7.6, 7.2 and 7.1, respectively. Hog plum pickle showed similar trends, with appearance, texture and overall acceptability decreasing from 8.1, 8.0 and 7.8 to 7.3, 7.1 and 7.4, respectively, while flavor reductions were non-significant. Kurbett and Khyadagi (2022) stored dehydrated acid lime pickle in low-density polyethylene and aluminum pouches at ambient temperature (25 ± 4°C) for six months and found slight changes in organoleptic properties, but the product remained within acceptable sensory limits.

The sensory scores of Hog Plum Marmalade (HPM3) and Control Marmalade (HPMC) were evaluated for 90-days storage at ambient temperature (33 ± 2°C). Both products showed a significant decline ($p<0.05$) in appearance, color, texture, flavor and overall acceptability over time. The control marmalade had a more noticeable decrease in sensory scores (appearance: 8.2 to 7.6, color: 8.8 to 7.4, texture: 8.7 to 7.6, flavor: 8.5 to 7.4 and overall acceptability: 8.5 to 7.4) compared to Hog Plum Marmalade, where changes were less significant (appearance: 8.1 to 7.5, colour: 8.22 to 7.6, texture : 8.1 to 7.2, flavor : 7.8 to 7.3 and overall acceptability: 7.8 to 7.4). A similar study by Fadly *et al.* (2021) on carrot-navel orange marmalade showed minimal changes in sensory properties during storage, with formulations containing more carrot declining in overall acceptability due to stronger carrot flavor over time.

Physico-Chemical Parameters of RTE Hog Plum Products on Storage

Physico-chemical parameters of RTE Hog Plum productson storage is depicted in Table 7. The moisture content increased significantly over the 90th day of storage in both control (5.0% initially

TABLE 5

Proximate composition of best accepted RTE Hog Plum products (per 100g)

Products		Moisture (%)	Protein (g)	Fat (g)	Total ash (g)	Crude fibre (g)	*Carbo hydrate (g)	**Energy (Kcal)
Chutney	Control	8.80	8.40	7.60	1.70	4.42	13.10	152
powder	HPCP4	8.30	8.82	7.70	1.80	16.75	14.70	164
Pickle	Control	40.6	1.90	1.80	1.40	3.40	12.40	73.4
	HPP4	40.6	2.50	2.10	1.50	24.1	13.50	77.3
Marmalade	Control	75.4	0.90	0.10	0.20	0.40	23.00	96
	HPM3	51.4	1.00	0.10	0.40	18.8	28.00	117

Note : *Carbohydrate by difference method and **Energy by computation, HPCP4 – Hog plum *Chutney* powder, HPP4 - Hog plum Pickle HPM3-Hog plum Marmalade

TABLE 6

Mean sensory scores of ready-to-eat (RTE) products from Hog Plum on storage

Storage intervals	Sensory Parameters											
	Appearance		Colour		Texture		Flavor		Taste		Overall acceptability	
Chutney Powder	HPCPC	HPCP4	HPCPC	HPCP4	HPCPC	HPCP4	HPCPC	HPCP4	HPCPC	HPCP4	HPCPC	HPCP4
Initial	8.2	8.1	8.7	8.1	8.6	8.0	8.5	7.8	8.6	7.7	8.4	7.8
30thday	7.6	7.6	8.6	7.7	8.1	7.7	7.5	7.4	8.4	7.6	7.8	7.6
60thday	7.4	7.5	7.4	7.5	7.6	7.5	7.4	7.3	7.4	7.5	7.6	7.5
90thday	7.3	7.5	7.1	7.4	7.4	7.1	7.2	7.3	7.2	7.4	7.5	7.4
Fvalue	*	*	*	*	*	*	*	NS	*	NS	*	NS
SEm±	0.11	0.11	0.11	0.11	0.10	0.13	0.12	0.15	0.11	0.14	0.11	0.13
CD@5%	0.31	0.33	0.32	0.32	0.3	0.39	0.35	-	0.36	-	0.30	-
Pickle	HPPC	HPP4	HPPC	HPP4	HPPC	HPP4	HPPC	HPP4	HPPC	HPP4	HPPC	HPP4
Initial	8.3	8.1	8.4	8.1	8.4	8.0	8.3	7.8	8.7	7.7	8.5	7.8
30thday	7.8	7.6	8.1	7.7	8.0	7.7	7.9	7.4	8.4	7.6	7.4	7.6
60thday	7.6	7.5	7.8	7.5	7.7	7.5	7.8	7.3	7.7	7.5	7.2	7.5
90thday	7.5	7.3	7.5	7.4	7.5	7.1	7.6	7.3	7.2	7.4	7.1	7.4
F value	*	*	*	*	*	*	*	NS	*	*	*	*
SEm±	0.11	0.11	0.10	0.11	0.11	0.13	0.12	0.15	0.13	0.14	0.11	0.13
CD@5%	0.35	0.33	0.33	0.32	0.32	0.39	0.35	-	0.33	0.34	0.28	0.32
Marma -lade	HPMC	HPM3	HPMC	HPM3	HPMC	HPM3	HPMC	HPM3	HPMC	HPM3	HPMC	HPM3
Initial	8.2	8.1	8.8	8.2	8.7	8.1	8.5	7.8	8.6	7.7	8.5	7.8
30thday	7.8	7.7	8.2	7.8	8.5	7.7	7.8	7.4	8.0	7.6	7.8	7.6
60thday	7.7	7.6	7.7	7.7	7.7	7.6	7.6	7.3	7.7	7.5	7.7	7.5
90thday	7.6	7.5	7.4	7.6	7.6	7.2	7.4	7.3	7.5	7.4	7.4	7.4
Fvalue	*	*	*	*	NS	*	NS	NS	*	NS	*	NS
SEm±	0.10	0.13	0.12	0.12	0.30	0.15	0.38	0.13	0.11	0.14	0.10	0.15
CD@5%	0.30	0.35	0.33	0.34	-	0.38	-	-	0.32	-	0.28	-

HCPC - Control *chutney* powder, HPCP4 - Hog Plum *chutney* powder, HPPC - Control pickle, HPP4 - Hog Plum pickle, HPMC - Control marmalade, HPM3 - Hog Plum marmalade, *Significant at 5%, NS - non significant

to 6.2) and Hog Plum chutney powder (5.15% to 6.2%). The increase in moisture could be due to the hygroscopic nature of the *chutney* powder, absorbing moisture from the environment during storage. The peroxide value, which indicates fat oxidation and product rancidity, increased significantly from 2.5 to 3.8m eqO2/kg in control and from 3.0 to 3.4m eqO2/kgin Hog Plum chutney powder suggesting lipid oxidation over time. Ascorbic acid, which is sensitive to storage conditions,

TABLE 7

Physico-chemical parameters of RTE Hog Plum products on storage

RTE products	Variations	Parameters	Durations						
			Initial	30th day	60th day	90th day	F value	SEm±	CD@ 5%
Chutney powder	Control	Moisture (%)	5.0	5.2	6.1	6.2	*	0.04	0.12
		Peroxide value (meq O2/kg)	2.5	3.1	3.4	3.8	*	0.03	0.13
		Ascorbic acid (mg/100g)	33.2	33.1	32.2	32.1	*	0.02	0.12
	HPCP4	Moisture (%)	5.15	5.2	6.2	6.2	*	0.04	0.14
		Peroxide value (meq O2/kg)	3.00	3.2	3.3	3.4	*	0.02	0.16
		Ascorbic acid (mg/100g)	23.3	23.1	22.3	22.2	*	0.02	0.13
Pickle	Control	Moisture (%)	50.2	51.7	60.8	62.9	*	0.03	0.12
		TSS	8.0	8.2	9.2	10.1	*	0.02	0.15
		Ascorbic acid (mg/100g)	22.8	22.7	22.6	22.5	*	0.04	0.14
	HPP4	Moisture (%)	50.2	51.3	51.2	53.4	*	0.03	0.14
		TSS	8.2	8.2	9.1	9.5	*	0.02	0.13
		Ascorbic acid (mg/100g)	14.8	14.6	14.4	13.2	*	0.04	0.12
Marmalade	Control	Moisture (%)	27.2	27.9	28.1	29.2	*	0.04	0.12
		pH	2.6	2.8	2.9	2.9	*	0.02	0.14
		TSS	53.2	57.9	58.0	59.2	*	0.02	0.16
	HPM3	Moisture (%)	27.2	28.0	28.1	29.1	*	0.03	0.14
		pH	2.54	2.7	2.8	2.9	*	0.04	0.13
		TSS	66.0	66.8	67.3	67.5	*	0.03	0.12

HPCP4 - Hog plum *chutney* powder, HPP4 - Hog plum pickle, HPM3 - Hog plum marmalade,
TSS = Total soluble sugar, *Significant at 5%

showed a slight decline, were it is decreased from 33.2 to 32.1 mg/100g in control and 23.3 to 22.2 mg/100g in Hog Plum *chutney* powder, which is likely due to the degradation of vitamin C during storage. Here's the corrected version of your sentence: Rao *et al.* (2008) reported that during six months of storage, the moisture content of raw mango chutney powder increased from 8.5 to 10.2 per cent, peroxide values rose from 2.5 to 4.0m eq/kg and ascorbic acid content declined from 45 to 30 mg/100g. A similar trend was observed in a study by Raju and Begum (2023).

As storage period increases moisture content of both control (50.2% to 62.9%) and Hog Plum pickle (50.2% to 53.4%) also increases significantly from initial to 90th day. The increase in moisture content is typical in pickles, as the high salt content draws moisture from the fruit tissues. Total soluble solids (TSS), which measure the sugar content, also increased over time, rising from 8.0 to 10.1 per cent in control and 8.2 to 9.5 per cent in Hog Plum pickle. This increase could be due to the concentration of sugars during fermentation or due to water loss. The ascorbic acid levels dropped slightly, from 22.8 to 22.5 mg/100g in the control and from 14.8 to 13.2 mg/100g in the Hog Plum pickle, reflecting the gradual loss of vitamin C due to oxidative processes during storage. Singh *et al.* (2022) reported an increase

TABLE 8

Effect of storage on microbial population of best accepted HogPlum based RTEproducts on storage

RTE products	Variations	Microorganisms	Durations			
			Initial	30thday	60thday	90thday
Chutney powder	Control	*TBC*(×105cfu/g)	ND	ND	0.02	0.04
		Yeast (×102cfu/g)	ND	ND	ND	ND
		Coliform (cfu/g)	ND	ND	ND	ND
	HPCP4	*TBC*(×105cfu/g)	ND	ND	0.03	0.04
		Yeast (×102cfu/g)	ND	ND	ND	ND
		Coliform (cfu/g)	ND	ND	ND	ND
Pickle	Control	*TBC*(×105cfu/g)	ND	ND	ND	0.13
		Yeast (×102cfu/g)	ND	ND	ND	ND
		Coliform (cfu/g)	ND	ND	ND	ND
	HPP4	*TBC*(×105cfu/g)	ND	ND	ND	0.13
		Yeast (×102cfu/g)	ND	ND	ND	ND
		Coliform (cfu/g)	ND	ND	ND	ND
Marmalade	Control	*TBC*(×105cfu/g)	ND	0.33	0.33	0.45
		Yeast (×102cfu/g)	ND	ND	ND	ND
		Coliform (cfu/g)	ND	ND	ND	ND
	HPM3	*TBC*(×105cfu/g)	ND	0.33	0.33	0.44
		Yeast (×102cfu/g)	ND	ND	ND	ND
		Coliform (cfu/g)	ND	ND	ND	ND

HPCP4 - Hog plum *chutney* powder, HPP4 - Hog plum pickle, HPM3 - Hog plum marmalade,
TBC - Total bacterial count, ND - Not detected

in moisture content of mango pickle from 54.0 to 60.5 per cent during storage, which may affect its texture and flavor. Additionally, the ascorbic acid content decreased significantly from 20.0 mg/100 g to 12.5 mg/100 g.

In marmalade, the moisture content significantly increased as days of storage increased in both control (27.2% to 29.2%) and in Hog plum marmalade (27.2% to 29.1%), respectively. The pH remained relatively stable in both variations, showing only a slight increase. This indicates that the acidity of the marmalade was maintained throughout the storage period. The TSS showed a consistent rise in both variations, reflecting an increase in sugar concentration. In the control, TSS rose from 53.2 to 59.2 per cent, while in the Hog Plum marmalade, it increased from 66.0 to 67.5 per cent. Estaji *et al*. (2020), who noted a decrease in TSS in black plum peel marmalade, the Hog Plum marmalade demonstrated an increase in TSS, indicating enhanced sugar concentration and effective preservation of acidity throughout storage.

Shelf-life Study of RTE Hog Plum Products by Microbial Analysis

Shelf-life study of RTE Hog Plum products by microbial analysis is depicted in Table 8. In Hog Plum chutney powder, the microbial load was minimal

through out the storage period. In both the control and Hog Plum *chutney* powder, no bacterial or yeast growth was detected initially or on the 30th day. By the 60th and 90th day, the TBC was still very low, with values of 0.02×10^5 cfu/g in the control and 0.03×10^5 cfu/g in the Hog Plum *chutney* powder. These values increased slightly by the 90th day, but the TBC remained low, indicating good microbial stability. Yeast and coliforms were not detected (ND) in any of the samples throughout the storage period, suggesting that the product was well-preserved, likely due to its low moisture content and acidity, which inhibit microbial growth.

In Hog Plum pickle, no microbial growth was detected in either the control or Hog Plum pickle until the 60th day and TBC reached 0.13×10^5 cfu/g in both variations on 90th day of storage. This slight increase in bacterial count could be due to the high moisture content of the pickle, which can support microbial growth over time, even in acidic environments. However, the yeast and coliform counts remained undetectable throughout storage.

Al-Azzawi and Al-Abdullah (2019) Studied on physico-chemical and nutritional properties of some processed pickles and microbial quality of processed pickles was evaluated during storage. The results showed that total bacterial count remained within acceptable limits throughout the storage period and no significant growth of molds or E. Coli was detected, indicating good microbial stability of the products.

In both the control and Hog Plum marmalade, TBC was not detected initially but rose to 0.33×10^5 cfu/g by the 30th and 60th day in both control and Hog plum marmalade. By the 90th day, the bacterial count slightly increased to 0.45×10^5 cfu/g in the control and 0.44×10^5 cfu/g in the Hog Plum marmalade. This pattern could be explained by the high sugar content in marmalade, which may initially inhibit bacterial growth but could allow for some microbial activity as the product ages. Despite the slight bacterial presence, yeast and coliforms were not detected in any samples, indicating that the product remained microbiologically safe over the 90-days storage period. Estaji *et al*. (2020) reported that no microbial contamination, including bacterial and mold growth, was detected in the marmalade samples throughout the storage period, ensuring the product's microbial stability.

The developed RTE Hog plum value-added products *viz.*, *chutney* powder, pickle and marmalade demonstrated their potential as versatile and nutritious food items. The *chutney* powder exhibited excellent microbial stability throughout storage, attributed to its low moisture content and acidity. Pickle preparation retained the fruit's unique tangy flavor, enhanced by its rich nutrient profile and acceptable sensory qualities. Marmalade made from fresh Hog Plum showcased vibrant color, desirable texture and significant antioxidant activity, highlighting its functional food potential. These products not only add value to Hog Plum but also provide an opportunity for commercial utilization and consumer health benefits.

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