International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(10): 709-720
www.biochemjournal.com
Received: 07-07-2025
Accepted: 11-08-2025

SS Ghule
M.Sc. Scholar, Department of Post Harvest Management of Fruit, Vegetable and Flower Crops, Post-Graduate Institute of Post-Harvest Technology and Management, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

Dr. GD Shirke
Head of Department, Post Harvest Management of Medicinal, Aromatic, Plantation, Spices and Forest Crops, Post-Graduate Institute of Post-Harvest Technology and Management Killa-Roha, Maharashtra, India

SP Salvi
Assistant Professor, Post Harvest Management of Fruit Vegetable and Flower Crops, Post-Harvest Technology and Management Killa-Roha, Maharashtra, India

Dr. RC Ranveer
Professor (CAS), Department of PHM of Meat, Poultry and Fish, Post-Graduate Institute of Post-Harvest Technology and Management, Killa-Roha, Maharashtra, India

Dr. PB Sanap
Head of Department, Post Harvest Management of Fruit Vegetable and Flower Crops, Post-Harvest Technology and Management Killa-Roha, Maharashtra, India

Dr. JH Kadam
Principal Scientist (Fruit Science), ICAR-NIASM Former Professor (CAS), Department of PHM of MAPSF, PGI-PHTM, Killa Roha, Maharashtra, India

Corresponding Author:
SS Ghule
M.Sc. Scholar, Department of Post Harvest Management of Fruit, Vegetable and Flower Crops, Post-Graduate Institute of Post-Harvest Technology and Management, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

Utilization of jackfruit (*Artocarpus heterophyllus* L.) seeds for the preparation of chips

SS Ghule, GD Shirke, SP Salvi, RC Ranveer, PB Sanap and JH Kadam

DOI: https://www.doi.org/10.33545/26174693.2025.v9.i10Si.5907

Abstract
An experiment entitled, "Utilization of jackfruit (*Artocarpus heterophyllus* L.) seeds for the preparation of chips" was conducted in the Department of PHM of Fruit, Vegetable and Flower Crops, PGI of PHTM, Killa-Roha, Dist. Raigad, during the year 2024-2025. The experiment was carried out in Factorial Completely Randomized Design (FCRD) with two experiments. Experiment no. 1 contains four main treatments: T_1: Hot water blanching (Control), T_2: 2% Brine solution blanching, T_3: 2% Alum solution blanching and T_4: 1% Citric acid blanching, three sub treatments: S1: 60 sec, S2: 120 sec and S3: 180 sec and three replications and experiment no. 2 contain two main treatments (best from experiment 1), three different frying temperature F1: 140 °C, F2: 160 °C and F3: 180 °C and three frying time A1: 1 min, A2: 3min and A3: 5min. Jackfruit seed chips were analysed for physical, chemical and sensory quality parameters at 0, 30, 60 and 90 days of storage period at ambient conditions. From the present investigation, it was observed that the 2% alum solution blanching for 3 minute showed lowest browning index. On the basis of sensory attributes, the jackfruit seed chips fried at 140 °C for 3min showed best overall acceptability. Also, it was observed that the chemical parameters such as carbohydrates, ash, protein, fat, and peroxide value exhibited a decreasing trend during storage period of 90 days at ambient conditions and moisture and fat content showed increasing trend up to 90 days of storage.

Keywords: Jackfruit seed chips, deep fat frying, frying time, storage, fat, moisture, ash, peroxide value, carbohydrates

1. Introduction

The tropical climacteric fruit *Artocarpus heterophyllus* L., also known as jackfruit, is a member of the Moraceae family which includes around 1200 species and 40 genera. Among them, *Artocarpus heterophyllus* is the most important species, having a somatic chromosomal number of 56 (2n = 4x = 56) and basic chromosome number is 14 (Kishore, 2018) [11]. The Indian Western Ghats are the native home of jackfruit. It is also widely grown in Asia, Africa and certain parts of South America. It is considered as the world's largest edible fruit. jackfruit is a nutrient-dense fruit with a high proteins, carbs, minerals, vitamins and phytochemicals. While the completely ripe flesh of the jackfruit can be eaten straight away as a fruit, the seeds are used in curries and boiled forms. The tree is monoecious and the inflorescences of both sexes are present on the same tree. Cross-pollination is used for fertilization and seeds are mostly used for propagation (Ranasinghe *et al*. 2019) [23].

The majority of India's jackfruit is produced in the area that includes Kerala, Orissa, West Bengal and Assam. According to India's state wise jackfruit production in year 2023-2024 Kerala ranks first in production (1,521.62 tons) followed by Orissa (317.19 tons) and West Bengal (227.81 tons) (Anonymous, 2024) [3]. In 2023-24 Maharashtra is on eighteenth position in production of jackfruit producing around 0.52 tons (000 tonnes) jackfruit annually (Anonymous, 2024) [3]. In year 2024-25 the total production of jackfruit in India is 3327.55 MT over a total area of 188.02 hector and in Maharashtra the total production of jackfruit is 8390.0 MT over a total area of 460 ha. (Anonymous, 2025) [4].

1.1 Jackfruit seed

Minerals, protein, and carbohydrates found abundant in jackfruit seeds. Jackfruit seeds are rich in fat, phosphate, potassium and carbs.

According to Praveenasri *et al*. (2006) [20], the jackfruit seed has 64.5% moisture content, 25.8 g of carbs, 135 Kcal of calories, 6.6 g of proteins, 1.2 g of total minerals, 1.5 mg of iron, 50 mg of calcium, 97 mg of phosphorus, and 1.5 mg of fibre, vitamin per 100 g of edible portion. Jackfruit seeds contain maximum energy (165 kcal) and more carbohydrates (36.7 kcal) than both young and mature jackfruit.

The fruit is divided into three parts: the rind (48%), seeds (18%) and bulbs (34%). The seed measures 1.5 to 2.5 cm thick and 2-4 cm long. A single fruit may contain 100-120 or even 500 seeds, which make up 5-6% of the overall fruit. Usually, the rind and seeds are thrown away. The jackfruit seeds, which make up between 5.1% and 12% of the fruit. It is consumed after boiling or roasting (Rajarajeshwari and Prakash, 1999) [21].

Jackfruit seeds are believed to lower the risk of heart attacks and irritable bowel syndrome because of their high fiber content. Seeds contain the resistant starch which helps to control blood sugar and keeps the gut healthy. In addition to having antibacterial qualities that help prevent foodborne illnesses, jackfruit seeds also contain a lectin known as jacalin, which can be used to gauge an HIV patient's immunological response. Due to its high magnesium content, which is necessary for calcium absorption and helps to strengthen bones while preventing diseases like osteoporosis, this seed is also beneficial for bone health (Maurya and Mogra, 2016) [15]. The seeds contain starch which is considered as useful in relieving biliousness, besides the roasted seeds are considered as an aphrodisiac. For good hair growth jackfruit seeds are very beneficial, besides, assist in healthy blood circulations (Swami *et al*. 2012) [29]. In China, the seeds are known to be beneficial in overcoming the toxicity due to alcohol and likewise, in India, the seeds are a crucial component of an antidote produced for heavy drinkers (Butool and Butool, 2015) [5]. Soong and Barlow (2004) [27] suggested the use of jackfruit seeds as a source of natural food additives and ingredients.

2. Material and Methods

The present work was carried out at PG Institute of post-harvest management, Killa-Roha, Dist. Raigad, Maharashtra, India during 2024-2025.

2.1 Procedure for preparation of Jackfruit seed chips

Fresh, disease free clean whole matured jackfruit (*Artocarpus heterophyllus* L.) seeds of average weight 9-12 kg procured from local market. The seeds were thoroughly washed under potable water and peeled manually. Chips slicer was used for slicing the jackfruit seeds vertically into appropriate size of 2mm thickness. The slices were blanched in different solutions (Hot water, 2% brine solution, 2% alum solution and 1% citric acid solution) for three different time (60, 120 and 180 sec), drained and fried in refined palm oil by using a deep fat fryer. Frying was done at three different temperatures (140,160 and 180 ºC) and at three different times (1, 3 and 5 min). The oil was preheated to the frying temperature prior to frying. The fried crisps were drained in a sieve and thereafter spread on paper towel to absorb excess oil and add 2% salt for flavour. The jackfruit seeds chips were allowed to air cool to room temperature and then packaged in both side aluminium foil bags (60 + micron) to prevent moisture loss before quality analysis and stored for 3 months storage period.

2.2 Compositional analysis

Moisture content of jackfruit seeds chips was determined by the oven-drying AOAC Method (A.O.A.C, 2020) [1]. Ash was determined by Method (A.O.A.C, 2020) [1]. Crude protein was determined by using Kjeldahl technique (A.O.A.C, 2020) [1] for determination of the total nitrogen in the sample, followed by multiplication of the nitrogen value by a 6.25 (A.O.A.C, 2020) [1]. Oil content was determined as the crude fat using AOAC Method (A.O.A.C, 2020) [1]. Crude fibre was determined as the acid-detergent method (Rangana, 1986) [24]. Total carbohydrate was calculated by difference methods (A.O.A.C, 2020) [1]. Peroxide value was determined according to the procedure of FSSAI (Food Safety Standards Authority of India), manual of methods of analysis of foods oils and fats, 2016 [7].

2.3 Organoleptic Analysis

The Trained panel of student and staff evaluated the samples at different aspects such as colour, flavour, texture and hardness using 9-point hedonic scale (Larmond, 1977) [13]. All samples were blindly coded with alphabets and numbers. The sensory evaluation was done on the basis of numerical sensory card based on BIS: 6273 (Part II, 1971). A total of 18 samples were evaluated.

2.4 Experimental details

The experiments were conducted in Factorial Completely Randomized Design (FCRD). The observations were recorded at the 0, 30, 60 and 90 days of storage period was taken for the statistical analysis.

2.5 Storage behaviour of jackfruit seed chips

The deep-fried jackfruit seed chips were stored in 60 + (micron) both side aluminium foil bag at ambient temperature conditions to study the storage behaviour of the jackfruit seed chips with respect to the changes in chemical parameters during storage. The product was evaluated immediately after preparation and at an interval of 0 days up to 90 days of storage.

2.6 Statistical analysis

The data collected on physical parameters such as L*, a* and b* value for colour and chemical parameters such as Browning index, moisture, ash, fat, protein, crude fiber, carbohydrate and peroxide value were represented as mean values. The data collected on the changes in physical and chemical parameters of deep-fried jackfruit seed chips during storage were statistically analysed by standard procedure given by Panse and Sukhatme (1985) [18] using Factorial Completely Randomised Design and valid conclusions were drawn only on significant differences between treatment mean at 5 percent level of significance.

3. Results and Discussion

3.1 Browning Index (BI)

In all treatments as the blanching time increases from 60 sec-180 sec at 93 °C the browning index decreases from 0.271-0.151 in T_1 (control), 0.247-0.144 in T_2 (2% brine solution), 0.2210.115 in T_3 (2% alum solution) and 0.228-0.138 in T_4 (1% citric acid solution) In comparison to all, the chips blanched in 2% alum solution (T_3) for 180sec. shows less browning index followed by T_4, T_2 and T_1, respectively.

The results related to the browning index of Jackfruit seed chips presented in the Table1 showed statistically non-significant difference due to the treatment. The highest mean of browning index was observed in treatment T_1 (0.203), followed by treatment T_2 (0.187). The lowest mean of browning index was observed in treatment T_3 (0.158), followed by treatment T_4 (0.171). so, from the above data T_3S3 (2% alum solution for 180sec. blanching) was observed lowest browning index so which shows it is the best treatment interaction. On the basis of browning index treatment interaction T_3S3 (2% Alum solution blanching for 180 sec.) and T_1S3 (Control-hot water blanching for 180 sec.) was used for experiment no.2.

Table 1: Effect of blanching solutions and blanching time on Browning index of Jackfruit seed chips

Treatments(T)	Browning index (BI)			
	Blanching time (sec.)			
	S1	S2	S3	Mean
T_1	0.271	0.188	0.151	0.203
T_2	0.247	0.169	0.144	0.187
T_3	0.221	0.138	0.115	0.158
T_4	0.228	0.147	0.138	0.171
Mean (S)	0.242	0.161	0.137	
Factors	SE(m)±		C.D. at 5%	
Factor (T)	0.066		0.200	
Factor (S)	0.094		0.283	
Factor (T×S)	0.132		NS	

T_1: Hot water blanching
T_3: 2% Alum solution blanching
T_2: 2% brine solution blanching
T_4: 1% Citric acid solution blanching

3.2 Effect of frying temperature and frying time on physical parameters of jackfruit seed chips

3.2.1 Colour (L*, a* and b* values)

3.2.1.1 L* Value

It is noticed from the Table 2 that the L* in jackfruit seed chips was significantly decreases as frying temperature and frying time increases and the mean L* value for the colour of jackfruit seed chips varied significantly due to the treatments, frying temperature and frying time. The maximum (67.500) means L* value for colour was recorded in the treatment B2F1A1 (2% Alum solution blanched for 180 sec, frying at 140 °C for 1 min), followed by the treatment B1F1A1 (Control-Hot water blanched for 180 sec, frying at 140 °C for 1 min) which was (65.600). Minimum (41.400) mean L* value for colour was observed in the treatment B1F3A3 (control), followed by the treatment B2F3A3 (2% alum blanched, frying at 180 °C for 5 min). It is observed that the L* value in different treatment combinations of jackfruit seed chips was found to be statistically significant. The numerically maximum (53.822) mean value for L* value content was recorded in the treatment B2 (2% alum blanched for 3 min). The minimum (52.711) mean value for L* content was observed in the treatment B1 (Control-Hot water blanched for 3 min). Similar result was recorded by Raleng *et al.* (2022) [22] in chayote chips. In which colour values "L*" decreased from 61.76 to 53.9 when frying time and temperature increases. Park and Kim (2020) [19] reported that the "L*" values decreased in the frying of carrot chips at 180-190 °C; The study by Teruel *et al.* (2015) [30] indicated that the L* values of potato strips fried at 180 °C were decreased with the increase of frying time.

3.2.2 a* Value

It is noticed from the Table 2 that the a* value in jackfruit seed chips was significantly increases as frying temperature and frying time increases. The maximum (18.300) mean a* value for colour was recorded in the treatment B1F3A3(Control-Hot water blanched for 180 sec, frying at 180 °C for 5 min), followed by the treatment B2F3A3(2% alum solution blanched for 180 sec, frying at 180 °C for 5 min) which was (16.900). Minimum (5.000) mean a* value for colour was observed in the treatment B2F1A1 (2% alum blanched, frying at 140 °C for 1 min), followed by the treatment B1F1A1 (Control). It is observed that the a* value in different treatment combinations of jackfruit seed chips was found to be statistically non-significant. The numerically maximum (10.756) mean value for a* value was recorded in the treatment B1 (Control-Hot water blanched for 3 min). The minimum (9.856) mean value for a* value was observed in the treatment B2 (2% alum blanched for 3 min). Similar result was observed by Raleng *et al.* (2022) [22] in chayote chips. In which colour values "a*" increased as frying time and temperature increased.

3.2.3 b* Value

It is noticed from the Table 2 that the b* value in jackfruit seed chips was significantly increases as frying temperature and frying time increases. The maximum (35.600) mean a* value for colour was recorded in the treatment B1F3A3(Control-Hot water blanched for 180 sec, frying at 180 °C for 5 min), followed by the treatment B2F3A3(2% alum solution blanched for 180 sec, frying at 180 °C for 5 min) which was (34.400). Minimum (16.400) mean b* value for colour was observed in the treatment B2F1A1 (2% alum blanched, frying at 140 °C for 1 min), followed by the treatment B1F1A1 (Control). It is observed that the b* value in different treatment combinations of jackfruit seed chips was found to be statistically significant. The numerically maximum (25.044) mean value for b* value was recorded in the treatment B1 (Control-Hot water blanched for 3 min). The minimum (23.463) mean value for b* value was observed in the treatment B2 (2% alum blanched for 3 min). Similar result was noticed by Raleng *et al.* (2022) [22] in chayote chips. In which colour values "b*" decreased from 23.51 to 20.16 when frying time and temperature increases. The b* values of deep fat fried carrots were generally decreased with increasing frying time Park and Kim (2020) [19].

Table 2: Effect of frying temperature and frying time on L*, a* and b* value of jackfruit seed chips

Temperature	Time	L* value		a*		b*	
(°C)	(min)	Treatments (B)		Treatments (B)		Treatments (B)	
		B1 (T_1S3)	B2 (T_3S3)	B1 (T_1S3)	B2 (T_3S3)	B1 (T_1S3)	B2 (T_3S3)
140	1	65.600	67.500	5.700	5.000	17.800	16.400
	3	54.800	55.500	7.900	6.900	21.700	19.900
	5	52.800	54.800	11.600	10.900	26.500	24.200
160	1	62.800	63.100	6.700	5.600	18.900	17.600
	3	49.900	52.400	9.800	9.100	23.600	22.400
	5	45.700	47.400	14.000	12.900	30.300	27.900
180	1	55.500	54.700	8.000	7.200	22.400	21.600
	3	45.900	47.100	14.800	14.200	28.600	26.767
	5	41.400	41.900	18.300	16.900	35.600	34.400
Factors	-	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%
Factor (B)	-	0.038	0.110	0.043	0.122	0.049	0.141
Factor (F)	-	0.047	0.135	0.052	0.150	0.060	0.173
B × F	-	0.067	0.191	0.074	NS	0.085	0.244
Factor (A)	-	0.047	0.135	0.052	0.150	0.060	0.173
B × A	-	0.067	0.191	0.074	NS	0.085	0.244
F × A	-	0.082	0.234	0.09	0.259	0.104	0.299
B × F × A	-	0.115	0.331	0.128	0.366	0.147	0.423

Treatments	Frying temperature (F)	Frying time (A)
B1: Hot water blanching	F1: 140 °C	A1: 1 min
B2: 2% alum blanching	F2: 160 °C	A2: 3 min
	F3: 180 °C	A3: 5 min

3.1 Moisture (%)

It is noticed from the Table 3 that the moisture content in jackfruit seed chips was significantly decreases as frying temperature and frying time increases. The highest (1.760%) moisture content was recorded in the treatment interaction B1F1A1 (Control, fried at 140 °C for 1 min), followed by (1.680%) in the treatment interaction B2F1A1 (2% alum blanched, fried at 140 °C for 1 min). The lowest (0.742%) moisture content was recorded in the treatment interaction B2F3A3 (2% alum blanched, fried at 180 °C for 5 min), followed by (0.843%) in the treatment interaction B1F3A3 (Control, fried at 180 °C for 5 min). It is observed that the moisture content in different treatment combinations of jackfruit seed chips was found to be statistically non-significant. The maximum (1.252%) mean value for moisture content was recorded in the treatment B1 (Control-Hot water blanched for 3 min). The minimum (1.172%) mean value for moisture content was observed in the treatment B2 (2% alum blanched for 3 min). Similar result was observed by Fetuga *et al.* (2014) [6], Sweet potato crips from yellow fleshed root were produced at frying temperature of 150 °C, 160 °C, 170 °C and 180 °C and frying period of 3 min, 5 min, 8 min and 12 min. This study showed that as frying temperature and frying time increases the range of moisture content was decreases from 3.83-0.49%; Yodkraisri and Bhat (2012) [32], the initial moisture content of lotus rhizome was 23.36±0.2. At three different frying temperatures (180 °C, 190 °C and 200 °C), for the frying of lotus rhizome chips' moisture content (g/100g) was 4.80±3.3, 3.94±0.5 and 3.48±0.5, respectively; The moisture content of the raw potato strips was 79% wb; however, at different frying temperatures (i.e. 170 °C, 180 °C and 190 °C), it was 37.9%, 27.9% and 32.8%, respectively (Millin *et al*. 2016) [16]; The moisture content of fried carrots decreased with increasing frying time (Park and Kim. 2020) [19].

3.2 Carbohydrate (%)

It is noticed from the Table 3 that the carbohydrate content in jackfruit seed chips was significantly increases as frying temperature and frying time increases. The highest (82.326%) carbohydrate content was recorded in the treatment interaction B2F1A1 (2% alum blanched, fried at 180 °C for 5 min), followed by (81.521%) in the treatment interaction B1F3A3 (Control, fried at 180 °C for 5 min). The lowest (77.685%) carbohydrate content was recorded in the treatment interaction B1F1A1 (Control, fried at 140 °C for 1 min), followed by (78.197%) in the treatment interaction B2F1A1 (2% alum blanched, fried at 140 °C for 1 min). It is observed that the carbohydrate content in different treatment combinations of jackfruit seed chips was found to be statistically significant. The numerically maximum (80.278%) mean value for carbohydrate content was recorded in the treatment B2 (2% alum blanched for 3 min). The minimum (79.465%) mean value for carbohydrate content was observed in the treatment B1 (Control-Hot water blanched for 3 min). Similar result was observed by Fetuga *et al*. (2014) [6], Sweet potato crips from yellow fleshed root were produced at frying temperature of 150 °C, 160 °C, 170 °C and 180 °C and frying period of 3 min, 5 min, 8 min and 12 min. This study shows that as frying temperature and frying time increases the range of carbohydrate content also increased from 62.17-74.97%.

3.3 Ash (%)

It is noticed from the Table 3 that the ash content in jackfruit seed chips was significantly increases as frying temperature and frying time decreases. The highest (3.746%) ash content was recorded in the treatment interaction B2F3A3 (2% alum blanched, fried at 180 °C for 5 min), followed by (3.544%) in the treatment interaction B1F3A3 (Control, fried at 180 °C for 5 min). The lowest (2.742%) ash content was recorded in the treatment interaction B1F1A1 (Control, fried at 140 °C for 1 min), followed by (2.885%) in the treatment interaction B2F1A1 (2% alum blanched, fried at 140 °C for 1 min). It is observed that the ash content in different treatment combinations of jackfruit seed chips was found to be statistically significant. The numerically maximum (3.352%) mean value for ash content was recorded in the treatment B2 (2% alum blanched for 3 min). The minimum (3.214%) mean value for ash content was observed in the treatment B1 (Control-Hot water blanched for 3 min). Similar result was observed by Fetuga *et al*. (2014) [6], Sweet potato crips from yellow fleshed root were produced at frying temperature of 150 °C, 160 °C, 170 °C and 180 °C and frying period of 3 min, 5 min, 8 min and 12 min. The range of ash content was increased from 2.00-4.50%. As frying temperature and frying time increases the ash content also increases.

Table 3: Effect of frying temperature and frying time on Moisture (%), Carbohydrate (%) and Ash (%) content of jackfruit seed chips

Temperature (°C)	Time (min)	Moisture (%)		Carbohydrate (%)		Ash (%)	
		B1	B2	B1	B2	B1	B2
140	1	1.760	1.680	77.685	78.197	2.742	2.885
	3	1.244	1.196	78.678	79.535	3.098	3.264
	5	1.169	1.102	79.646	80.376	3.339	3.454
160	1	1.572	1.480	78.038	79.024	3.018	3.113
	3	1.156	1.106	79.539	80.351	3.227	3.385
	5	1.075	1.002	80.422	81.297	3.468	3.553
180	1	1.381	1.251	79.160	80.127	3.153	3.233
	3	1.070	0.987	80.496	81.272	3.334	3.533
	5	0.843	0.742	81.521	82.326	3.544	3.746
Factors	-	SE(m)±	C.D.at 5%	SE (m)±	C.D.at 5%	SE (m)±	C.D.at 5%
Factor (B)	-	0.002	0.007	0.002	0.005	0.003	0.007
Factor (F)	-	0.003	0.008	0.002	0.006	0.003	0.009
B × F	-	0.004	0.011	0.003	0.008	0.004	0.013
Factor (A)	-	0.003	0.008	0.002	0.006	0.003	0.009
B × A	-	0.004	0.011	0.003	0.008	0.004	0.013
F × A	-	0.005	0.014	0.003	0.01	0.006	0.016
B × F × A	-	0.007	NS	0.005	0.014	0.008	0.022

Treatments	Frying temperature (F)	Frying time (A)
B1: Hot water blanching	F1: 140 °C	A1: 1 min
B2: 2% alum blanching	F2: 160 °C	A2: 3 min
	F3: 180 °C	A3: 5 min

3.4 Protein (%)

It is noticed from the Table 4 that the protein content in jackfruit seed chips was significantly decreased as frying temperature and frying time increases. The highest (3.536%) protein content was recorded in the treatment interaction B2F1A1 (2% alum blanched, fried at 140 °C for 1 min), followed by (3.503%) in the treatment interaction B1F1A1 (Control, fried at 140 °C for 1 min). The lowest (2.965%) protein content was recorded in the treatment interaction B1F3A3 (Control, fried at 180 °C for 5 min), followed by (3.066%) in the treatment interaction B2F3A3 (2% alum blanched, fried at 180 °C for 5 min). It is observed that the protein content in different treatment combinations of jackfruit seed chips during 0 day was found to be statistically significant. The numerically maximum (3.291%) mean value for protein content was recorded in the treatment B2 (2% alum blanched for 3 min). The minimum (3.238%) mean value for protein content was observed in the treatment B1 (Control-Hot water blanched for 3 min). Similar result was observed by Fetuga *et al*. (2014) [6], Sweet potato crips from yellow fleshed root were produced at frying temperature of 150 °C, 160 °C, 170 °C and 180 °C and frying period of 3 min, 5 min, 8 min and 12 min. This study shows that as frying temperature and frying time increases the range of protein content was decreases from 1.42-0.10%.

3.5 Fat (%)

It is noticed from the Table 4 that the fat content in jackfruit seed chips was significantly decreased as frying temperature and frying time increases. The highest (12.860%) fat content was recorded in the treatment interaction B1F1A1 (Control, fried at 140 °C for 1 min), followed by (12.220%) in the treatment interaction B2F1A1 (2% alum blanched, fried at 140 °C for 1 min). The lowest (9.190%) fat content was recorded in the treatment interaction B2F3A3 (2% alum blanched, fried at 180 °C for 5 min), followed by (3.066%) in the treatment interaction B1F3A3 (Control, fried at 180 °C for 5 min). It is observed that the fat content in different treatment combinations of jackfruit seed chips was found to be statistically significant. The numerically maximum (11.586%) mean value for fat content was recorded in the treatment B1 (Control-Hot water blanched for 3 min). The minimum (10.716%) mean value for fat content was observed in the treatment B2 (2% alum blanched for 3 min). Similar result was observed by Fetuga *et al*. (2014) [6], Sweet potato crips from yellow fleshed root were produced at frying temperature of 150 °C, 160 °C, 170 °C and 180 °C and frying period of 3min, 5min, 8min and 12 min. This study shows that as frying temperature and frying time increases the range of fat content was decreases from 28.59-19.11%. According to Kita *et al*. (2007) [12], the crisps were fried in palm oil at temperatures of 150 °C, 170 °C and 190 °C, showing fat content of 42.32%, 38.13% and 37.04%, respectively. Similar result was observed by Garayo and Moreira (2002) [8], they revealed instead of being a function of oil temperature, the ultimate oil content of the potato chips was determined by frying time (and consequently moisture content), which rises as oil temperature drops. The potato crisps were fried in soybean oil at temperatures of 150 °C, 170 °C and 190 °C. Fat content in a potato crisp observed relative to temperature was 43.30%, 39.49% and 35.53%.

3.6 Peroxide value (meq/kg)

It is observed from the Table 4 that the peroxide value (meq/kg) in all treatments was recorded less than 0.1 (< 0.1).

Table 4: Effect of frying temperature and frying time on Fat (%), Protein (%) and Peroxide value of jackfruit seed chips

Temperature (°C)	Time (min)	Fat (%)		Protein (%)		Peroxide value (meq/kg)	
		B1	B2	B1	B2	B1	B2
140	1	12.860	12.220	3.503	3.536	< 0.1	< 0.1
	3	12.370	11.420	3.400	3.435	< 0.1	< 0.1
	5	11.550	10.740	3.326	3.378	< 0.1	< 0.1
160	1	12.460	11.477	3.302	3.346	< 0.1	< 0.1
	3	11.640	10.670	3.236	3.305	< 0.1	< 0.1
	5	10.880	10.030	3.185	3.255	< 0.1	< 0.1
180	1	11.617	10.720	3.133	3.176	< 0.1	< 0.1
	3	10.840	9.980	3.088	3.126	< 0.1	< 0.1
	5	10.057	9.190	2.965	3.066	< 0.1	< 0.1
Factors	-	SE(m)±	C.D.at 5%	SE (m)±	C.D.at 5%	-	
Factor (B)	-	0.006	0.017	0.001	0.002	-	
Factor (F)	-	0.007	0.02	0.001	0.002	-	
B × F	-	0.01	0.029	0.001	0.003	-	
Factor (A)	-	0.007	0.02	0.001	0.002	-	
B × A	-	0.01	0.029	0.001	0.003	-	
F × A	-	0.012	0.035	0.001	0.004	-	
B × F × A	-	0.017	0.05	0.002	0.006	-	

Treatments	Frying temperature (F)	Frying time (A)
B1: Hot water blanching	F1: 140 °C	A1: 1 min
B2: 2% alum blanching	F2: 160 °C	A2: 3 min
	F3: 180 °C	A3: 5 min

4.2.3.1 Colour

It is noticed from the Table 5 that the sensory colour in jackfruit seed chips was significantly decreased as frying temperature and frying time increases. The colour value in different treatment combinations of jackfruit seed chips was found to be statistically non-significant. The numerically maximum (6.019) mean value for colour was recorded in the treatment B2 (2% alum blanched for 3min). The minimum (5.694) mean was observed in the treatment. B1 (Control-Hot water blanched for 3 min). According to the data recorded the highest (8.000) mean value for colour was recorded in the treatment interaction B2F1A2 (2% alum blanched, fried at 140 °C for 3 min), followed by (7.500) in the treatment interaction B1F1A2. The lowest (4.000) value for colour was recorded in the treatment interaction B1F3A3 (Control, fried at 180 °C for 5 min), followed by (4.500) in the treatment interaction B2F3A3 (2% alum blanched, fried at 180 °C for 5 min). Similar trend was observed by Fetuga *et al*. (2014) [6] in sweet potato crips from yellow fleshed root were prepared at frying temp. of 150 °C, 160 °C, 170 °C and 180 °C and frying period of 3, 5, 8 and 12 min. Generally, at each frying temperature, there was a decrease in taste and colour scores with increase in frying time.

4.2.3.2 Flavour

It is observed from the Table 5 that the flavour in different treatment combinations of jackfruit seed chips was found to be statistically non-significant. The numerically maximum (6.500%) mean value for flavour score was recorded in the treatment B2 (2% alum blanched for 3 min). The minimum (6.028%) mean value for flavour was observed in the treatment. B1 (Control-Hot water blanched for 3 min). According to the data recorded the highest (8.000%) flavour score was recorded in the treatment interaction B2F1A2 (2% alum blanched, fried at 140 °C for 3 min), followed by (7.500%) in the treatment interaction B1F1A2 (Control, fried at 140 °C for 3 min). The lowest (5.000%) flavour score was recorded in the treatment interaction B1F3A3 (Control, fried at 180 °C for 5 min), followed by (5.500%) in the treatment interaction B2F3A3 (2% alum blanched, fried at 180 °C for 5 min). Similar result was noticed by Fetuga *et al*. (2014) [6] in sweet potato crips from yellow fleshed root were prepared at frying temp. of 150 °C, 160 °C, 170 °C and 180 °C and frying period of 3, 5, 8 and 12 min.

4.2.3.3 Texture/Crispiness

It is observed from the Table 5 that the texture in different treatment combinations of jackfruit seed chips was found to be statistically non-significant. The numerically maximum (6.259%) mean value for texture score was recorded in the treatment B2 (2% alum blanched for 3 min). The minimum (5.935%) mean value for texture was observed in the treatment B1 (Control-Hot water blanched for 3 min). According to the data recorded the highest (7.333%) texture score was recorded in the treatment interaction B2F1A3 (2% alum blanched, fried at 140 °C for 5 min), followed by (7.000%) in the treatment interaction B1F1A3 (Control, fried at 140 °C for 5 min). The lowest (4.000%) texture score was recorded in the treatment interaction B1F1A1 (Control, fried at 180 °C for 5 min), followed by (4.250%) in the treatment interaction B2F1A1 (2% alum blanched, fried at 180 °C for 5 min). Similar result was observed by Fetuga *et al*. (2014) [6] in sweet potato crips from yellow fleshed root were prepared at frying temp. of 150-180 °C and frying period of 3-12 min. respectively.

4.2.3.4 Overall acceptability

It is observed from the Table 5 that the overall acceptability score in different treatment combinations of jackfruit seed chips was found to be statistically significant. The numerically maximum (6.259%) mean value for overall acceptability score was recorded in the treatment B2 (2% alum blanched for 3 min). The minimum (5.886%) mean value for overall acceptability was observed in the treatment B1 (Control-Hot water blanched for 3 min). According to the data recorded the highest (7.611%) overall acceptability score was recorded in the treatment interaction B2F1A2 (2% alum blanched, fried at 140 °C for 3 min), followed by (7.167%) in the treatment interaction B1F1A2 (Control, fried at 140 °C for 3 min). The lowest (4.944%) overall acceptability score was recorded in the treatment interaction B1F3A3 (Control, fried at 180 °C for 5 min), followed by (5.389%) in the treatment interaction B2F3A3 (2% alum blanched, fried at 180 °C for 5 min). Similar result was observed by Fetuga *et al*. (2014) [6] in sweet potato crips from yellow fleshed root were produced at frying temp. of 150-180 °C and frying period of 3-12 min. respectively.

It is observed from the Table no. 5 that on the basis of overall sensory acceptability the treatment B2F1A2 (2% alum blanched, fried at 140 °C for 3 min) was best.

Table 5: Effect of frying temperature and frying time on Colour, Flavour, Texture and Overall acceptability of jackfruit seed chips

Temperature (°C)	Time (min)	Colour Treatment		Flavour Treatment		Texture Treatment		Overall acceptability Treatment	
		B1	B2	B1	B2	B1	B2	B1	B2
140	1	6.083	6.250	6.000	7.000	4.000	4.250	5.361	5.833
	3	7.500	8.000	7.500	8.000	6.500	6.833	7.167	7.611
	5	5.167	5.500	6.500	7.000	7.000	7.333	6.222	6.611
160	1	5.750	5.917	6.000	6.500	5.000	5.333	5.582	5.917
	3	6.500	6.750	6.250	6.667	6.750	7.000	6.500	6.806
	5	5.000	5.500	5.667	5.917	6.833	7.250	5.833	6.222
180	1	5.750	6.000	5.833	6.167	5.250	5.667	5.612	5.944
	3	5.500	5.750	5.500	5.750	6.250	6.500	5.750	6.000
	5	4.000	4.500	5.000	5.500	5.833	6.167	4.944	5.389
Factors		SE(m)±	C.D.at 5%	SE(m)±	C.D.at 5%	SE(m)±	C.D.at 5%	SE(m)±	C.D.at 5%
Factor (B)		0.056	0.157	0.064	0.179	0.048	0.135	0.000	0.001
Factor (F)		0.068	0.192	0.078	0.220	0.059	0.165	0.000	0.001
B × F		0.097	NS	0.111	NS	0.083	NS	0.000	0.001
Factor (A)		0.068	0.192	0.078	0.220	0.059	0.165	0.000	0.001
B × A		0.097	NS	0.111	NS	0.083	NS	0.000	0.001
F × A		0.118	0.333	0.135	0.38	0.102	0.286	0.001	0.002
B × F × A		0.167	NS	0.191	NS	0.144	NS	0.001	0.002

Treatments	Frying temperature (F)	Frying time (A)
B1: Hot water blanching	F1: 140 °C	A1: 1 min
B2: 2% alum blanching	F2: 160 °C	A2: 3 min
	F3: 180 °C	A3: 5 min

4.3 To study the physiochemical changes in jackfruit seed chips during storage

4.3.1 L* value for colour

It is clear from the table 6 that the mean L* value for the colour of jackfruit seed chips varied significantly due to the treatments and storage periods. The highest (62.850) mean L* value for colour was recorded in the treatment C2 during storage, while lowest (61.090) mean L* value for colour was observed in the treatment C1 during storage. The L* value for colour of jackfruit seed chips showed significantly increasing trend during storage period. The maximum mean (66.980) L* value for lightness was noticed at 90 days of storage and minimum mean (55.150) L* value for lightness was recorded at 0 day of storage. Similar result of increase in L* value for colour during storage were reported by Manikantan *et al*. (2014) [14], In storage stability of banana chips up to 120 days.

4.3.2 a* value for colour

It is observed from the table 6 that the a* value for colour of jackfruit seed chips showed significantly decreasing trend during storage period. The maximum mean (7.400) a* value for redness was noticed at 0 day of storage and minimum mean (6.050) a* value for redness was recorded at 90 days of storage. The interaction between treatments and storage period for a* value for colour was found to be statistically non-significant. The highest (7.275) mean a* value for colour was recorded in the treatment C1 during storage, while lowest (6.200) mean a* value for colour was observed in the treatment C2 during storage. Identical result was found by Sulaeman *et al*. (2003) [28], In deep fried carrot chips during storage. The chips were stored for five months at three different conditions. In which chips stored at 29-31℃ and 89-93% r.h showed decreasing trend of a* value during storage period from 22.72-19.76. Similar result of decrease in a* value for colour during storage were reported by Manikantan *et al*. (2014) [14], In storage stability of banana chips up to 120 days.

4.3.3 b* value for colour

It is observed from the table 6 that the b* value for colour of jackfruit seed chips showed significantly deceasing trend during storage period. The maximum mean (20.800) b* value for colour was noticed at 0 day of storage and minimum mean (19.300) b* value for colour was recorded at 90 days of storage. The interaction between treatments and storage period for b* value for colour was found to be statistically non-significant. The highest (21.100) mean of b* value for colour was recorded in the treatment C1 during storage period, while lowest (18.200) mean of b* value for colour was observed in the treatment C2 during storage period. Similar observations were recorded by Sulaeman *et al*. (2003) [28], In deep fried carrot chips during storage. The chips were stored for 5 months at three different conditions. In which chips stored at 29-31℃ and 89-93% R.H showed decreasing trend of b* value during storage period from 19.90-16.84. Similar result of decrease in b* value for colour during storage were reported by Manikantan *et al*. (2014) [14], In storage stability of banana chips up to 120 days.

Table 6: Changes in the L*, a* and b* value for colour of jackfruit seed chips during storage

Storage duration (Days) (O)	Treatments (C)					
	L* Value		a* Value		b* value	
	C1 (B1F1A2)	C2 (B2F1A2)	C1 (B1F1A2)	C2 (B2F1A2)	C1 (B1F1A2)	C2 (B2F1A2)
0	54.800	55.500	7.900	6.900	21.700	19.900
30	60.000	62.800	7.500	6.400	21.400	19.300
60	63.100	65.600	7.100	6.000	20.900	18.800
90	66.470	67.500	6.600	5.500	20.400	18.200
Factor	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%
Factor (C)	0.062	0.188	0.055	0.166	0.066	0.200
Factor (O)	0.088	0.267	0.078	0.235	0.094	0.283
Factor (C X O)	0.125	0.377	0.110	NS	0.132	NS

C1: Control (Hot water blanching), frying temp.-140 °C, frying time-3 min
C2: 2% alum solution blanching, frying temp.-140 °C, frying time-3 min
O: Storage period (days)

4.4.1 Moisture (%)

It is noticed from the Table 7 that the moisture content in jackfruit seed chips increased significantly during storage. The lowest (1.220%) mean value for moisture content was found at initial day of storage and highest (1.415%) mean value for moisture content was recorded at 90 days of storage. According to the data recorded for the changes in moisture content in different treatments of jackfruit seed chips the results were found to be statistically non-significant. The numerically maximum (1.345%) mean value for the moisture content was observed in the treatment C1 (Control, frying temp.-140 °C, frying time-3 min). The minimum (1.301%) mean value for moisture content was recorded in the treatment C2 (2% alum blanched, frying temp.-140 °C, frying time-3 min). Similar result was observed by Yadav *et al*. (2018) [31], potato chips was stored for 0-90 days. The storage depicted significant increases in mean moisture content of each treatment. Also, found by Zehra (2018) [33], in storage of deep-fried Lotus Rhizome snacks. The moisture content increases significantly during storage. Similar result was recorded by Akubor and Adejo (2000) [2], In Physicochemical, microbiological and sensory change in stored plantain chips. The chips were stored for 3 months which showed the moisture content increases significantly from 10.38-12.36 (%) during storage.

4.4.2 Carbohydrate (%)

It is noticed from the Table 7 that the Carbohydrate content in jackfruit seed chips decreased significantly during storage. The highest (79.097%) mean value for Carbohydrates content was found at initial day of storage and lowest (77.603%) mean value for Carbohydrates content was recorded at 90 days of storage. According to the data recorded for the changes in Carbohydrates content in different treatments of jackfruit seed chips the results were found to be statistically significant. The maximum (78.785%) mean value for the Carbohydrates content was observed in the treatment C2 (2% alum blanched, frying temp.-140 °C, frying time-3 min). The minimum (77.992%) mean value for Carbohydrates content was recorded in the treatment C1 (Control, frying temp. 140 °C, frying time-3 min). The interaction effect between the different treatments and storage period of jackfruit seed chips were found to be statistically significant. Similar result was noticed by Sangma *et al.* (2022) [25], in jackfruit chips. The Carbohydrate content showed a decreasing trend with increase in storage time.

4.4.3 Ash (%)

It is noticed from the Table 7 that the ash content in jackfruit seed chips decreased significantly during storage. The highest (3.181%) mean value for ash content was found at initial day of storage and lowest (2.606%) mean value for ash content was recorded at 90 days of storage. According to the data recorded for the changes in ash content in different treatments of jackfruit seed chips the results were found to be statistically significant. The maximum (2.915%) mean value for the ash content was observed in the treatment C2 (2% Alum blanched, frying temp.-140 °C, frying time-3 min). The minimum (2.783%) mean value for ash content was recorded in the treatment C1 (Control, frying temp.-140 °C, frying time-3 min). The interaction effect between the different treatments and storage period of jackfruit seed chips were found to be statistically significant. Similar result was observed by Yadav *et al.* (2018) [31], potato chips were stored for 0-90 days. The storage showed significant decreasing trend in the mean values of ash content in each treatment.

Table 7: Changes in the moisture (%), Carbohydrates (%) and Ash (%) content of jackfruit seed chips during storage period

Storage duration (Days) (O)	Treatments (C)					
	Moisture (%)		Carbohydrates (%)		Ash content (%)	
	C1 (B1F1A2)	C2 (B2F1A2)	C1 (B1F1A2)	C2 (B2F1A2)	C1 (B1F1A2)	C2 (B2F1A2)
0	1.244	1.196	78.678	79.515	3.098	3.264
30	1.312	1.268	78.201	79.055	2.893	2.927
60	1.389	1.346	77.836	78.616	2.617	2.784
90	1.436	1.394	77.252	77.955	2.526	2.686
Factor	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%
Factor (C)	0.001	0.002	0.001	0.002	0.001	0.002
Factor (O)	0.001	0.003	0.001	0.002	0.001	0.003
Factor (C X O)	0.001	NS	0.001	0.003	0.001	0.004

C1: Control (Hot water blanching), frying temp.-140 °C, frying time-3 min
C2: 2% alum solution blanching, frying temp.-140 °C, frying time-3 min
O: Storage period (days)

4.4.4 Fat (%)
It is observed from the Table 8 that the fat content in jackfruit seed chips increased significantly during storage due to change in moisture content. The highest (14.285%) mean value for fat content was found at 90 days of storage and lowest (11.895%) mean value for fat content was recorded at initial day of storage. Based on the data collected for the changes in fat content in different treatments of jackfruit seed chips the results were determined to be statistically significant. The numerically maximum (13.537%) mean value for the fat content was observed in the treatment C1 (Control, frying temp.-140 °C, frying time-3 min). The minimum (12.652%) mean value for fat content was recorded in the treatment C2 (2% alum blanched, frying temp.-140 °C, frying time-3 min). The interaction effect between the different treatments and storage period of jackfruit seed chips were found to be statistically significant. Similar results were recorded by Gokhale (2024) [10], In jackfruit chips stored for 6 months storage period in four different packaging materials. The result showed that as the time of storage increases, the value of the fat content also increases. The change in fat content is due to the moisture content found in chips. Nagarathna (2017) [17] reported that due to increase in moisture content percent during storage duration hydrolysis of fat occurs inside chips, that improves fat content%. The similar results were observed by Satishkumar (2014) [26] while studies on jackfruit (*Artocarpus heterophyllus* L.) chip production and storage. The rise in free fatty acids in chips those were kept for 60 days, in both the varieties of jackfruit Tane Varikka and the Muttom Varikka.

4.4.5 Protein (%)
According to the data recorded form table 8 the changes in protein content in different treatments of jackfruit seed chips the results were found to be statistically significant. The numerically maximum (3.319%) mean value for the protein content was observed in the treatment C2 (2% Alum blanched, frying temp.-140 °C, frying time-3 min). The minimum (3.302%) mean value for protein content was recorded in the treatment C1 (Control, frying temp.-140 °C, frying time-3 min). Table 8 shows that during storage, the protein content of jackfruit seed chips dropped Significantly. The highest (3.418%) mean value for protein content was found at first day of storage and lowest (3.201%) mean value for protein content was recorded at 90 days of storage. It was determined that there was a statistically significant interaction effect between the treatments and the storage duration of jackfruit seed chips. Similar result was observed by Sangma *et al*. (2022) [25], in jackfruit chips. The Protein content showed a decreasing trend with increase in storage time.

4.4.6 Peroxide value (meq/kg)
It is observed from the Table 8 that the peroxide value (meq/kg) in both treatments was recorded less than 0.1 (< 0.1) at initial day of storage and 1.040 meq/kg in C1 and 0.980 meq/kg in C2 at 90 days of storage period. As the storage days increase, the peroxide value also increases. Similar result was observed by Ghafoor *et al*. (2020) [9], Effect of Frying on Physicochemical and Sensory Properties of Potato Chips Fried in Palm Oil Supplemented with Thyme and Rosemary Extracts. The result showed that the peroxide value (meq/Kg) of flate potato chips fried in PO (Palm oil) was increases from 1.00-2.02 meq/kg during 7 months of storage. Similar result was observed by Gokhale (2024) [10], In jackfruit chips stored for 6 months storage period in four different packaging materials. The result showed that the peroxide value (meq/kg) for all four samples of jackfruit chips is less than 0.1meq/kg, which was not developed up to six-month storage duration. As the storage days increase, the peroxide value also increases. The similar results were observed in studies on jackfruit (*Artocarpus heterophyllus* L.) chip production and storage (Satishkumar, 2014) [26].

Table 8: Changes in the Fat (%), Protein (%) and Peroxide value (meq/Kg) of jackfruit seed chips during storage period

Storage duration (Days) (O)	Treatments (C)					
	Fat content (%)		Protein content (%)		Peroxide value (meq/Kg)	
	C1 (B1F1A2)	C2 (B2F1A2)	C1 (B1F1A2)	C2 (B2F1A2)	C1 (B1F1A2)	C2 (B2F1A2)
0	12.370	11.420	3.400	3.435	<0.1	<0.1
30	13.160	12.260	3.334	3.360	0.160	0.140
60	13.940	13.040	3.268	3.284	0.750	0.810
90	14.680	13.890	3.206	3.196	1.040	0.980
Factor	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%
Factor (C)	0.006	0.019	0.001	0.002	-	-
Factor (O)	0.009	0.027	0.001	0.002	-	-
Factor (C X O)	0.012	0.038	0.001	0.003	-	-

C1: Control (Hot water blanching), frying temp.-140 °C, frying time-3 min
C2: 2% alum solution blanching, frying temp.-140 °C, frying time-3 min
O: Storage period (days)

4.5 Microbial analysis of jackfruit seed chips during storage
4.5.1 Total plate count (cfu/g) of jackfruit seed chips
The data regarding the total plate count of jackfruit seed chips during storage are presented in Table 9. It could be observed that the total plate count (cfu/g) was not detected in both treatments C1(B1F1A2) (Control (Hot water blanching), frying temp.-140 °C, frying time-3 min) and C2(B2F1A2) (2% alum solution blanching, frying temp.-140 °C, frying time-3 min) during storage period 90 days of storage at ambient conditions.
Related data was observed by Gokhale (2024) [10], In jackfruit chips which were stored for 6 months storage period in four different packaging materials. The result showed that the total plate count (cfu/g) for all four samples of jackfruit chips was not observed up to four-month storage.

Table 9: Changes in the TPC (Total plate count) (cfu/g) content of jackfruit seed chips during storage period

Treatments		Storage Period (Days)		
		Total Plate count (cfu/g)		
	0 day	30 days	60 days	90 days
C1(B1F1A2)	ND	ND	ND	ND
C2(B2F1A2)	ND	ND	ND	ND

C1: Control (Hot water blanching), frying temp.-140 °C, frying time-3 min
C2: 2% alum solution blanching, frying temp.-140 °C, frying time-3 min
O: Storage period (days)
ND: Not detected

4.6 Changes in sensory quality parameters of jackfruit seed chips during storage

4.6.1 Colour

Table 10 shows that during the 90-day storage period, there was a significant decrease in the colour sensory score. At 0 days of storage, the score was at its greatest (7.750), and at 90 days of storage, it was at its lowest (6.625). It was determined that there was no statistically significant interaction between the various treatments and the storage duration of jackfruit seed chips. The maximum mean (7.500) score for colour of jackfruit seed chips was recorded in the treatment C2 (2% Alum blanched, frying temp.-140 °C, frying time-3 min). The minimum mean (6.813) score was observed in the treatment C1 (Control, frying temp.-140 °C, frying time-3 min). Treatment C2 (2% alum blanched, frying temp.-140 °C, frying time-3 min) shows higher sensory score for flavour than C1 (Control, frying temp.-140 °C, frying time-3 min). Similar trend was recorded by Sulaeman *et al*. (2003) [28], In deep fried carrot chips during storage. The chips were stored for five months at three different conditions. In which chips stored at 29-31 °C and 89-93% RH showed decreasing trend of sensory score for colour during storage period; Similar result was recorded by Akubor and Adejo (2000) [2], In Physicochemical, microbiological and sensory change in stored plantain chips. The chips were stored for 3 months which showed decreasing trend in colour score from 3.9-3.5.

4.6.2 Flavour

It could be observed from the Table 10 that the sensory score for flavour was significantly decreased during storage period of 90 days. The highest (7.750) score was noticed at 0 day of storage and the lowest (6.167) score was recorded at 90 days of storage. Treatment C2 (2% Alum blanched, frying temp.-140 °C, frying time-3 min) shows higher sensory score for flavour than C1 (Control, frying temp.-140 °C, frying time-3 min). The maximum mean (7.188) score for flavour of jackfruit seed chips was recorded in the treatment C2 (2% alum blanched, frying temp.140 °C, frying time-3 min). The minimum mean (6.792) score was observed in the treatment C1 (Control, frying temp.-140 °C, frying time-3 min). The interaction effect between the different treatments and storage period of jackfruit seed chips were found to be statistically non-significant. Sulaeman *et al*. (2003) [28] saw a similar outcome with deep-fried carrot chips while they were being stored. For five months, the chips were kept in three distinct environments. Chips kept at 29-31 °C and 89-93% relative humidity exhibited a declining trend in their flavour sensory score with time. Similar result was recorded by Akubor and Adejo (2000) [2], In Physicochemical, microbiological and sensory change in stored plantain chips. The chips were stored for 3 months which showed decreasing trend in flavour score from 3.9 (at 0 day) to 3.0 (at 3rd month).

4.6.3 Texture/Crispness

It is observed from the Table 10 that the mean sensory score for texture of jackfruit significantly decreased with increase in the storage period of 90 days. It was highest 6.667 at the 0 day which was decreased to 5.500 at 90 days of storage at ambient condition. The maximum mean (6.208) score for texture of jackfruit seed chips was recorded in the treatment C2 (2% alum blanched, frying temp.140 °C, frying time-3 min). The minimum mean (5.896) score was observed in the treatment C1 (Control, frying temp.-140 °C, frying time-3 min). The interaction effect between the different treatments and storage period of jackfruit seed chips were found to be statistically non-significant. Similar result was noticed by Sulaeman *et al*. (2003) [28], In deep fried carrot chips during storage. The chips were stored for 5 months at three different conditions. In which chips stored at 29-31 °C and 89-93% RH showed decreasing trend of sensory score for texture or crispness during storage period; Similar result was recorded by Akubor and Adejo (2000) [2], In Physicochemical, microbiological and sensory change in stored plantain chips. The chips were stored for 3 months which showed decreasing trend in crispness from 4.0 (at 0 day) to 3.0 (at 3rd month).

4.6.4 Overall Acceptability

The results showed from Table 10 that as the storage duration of 90 days increased, the mean sensory score for the overall acceptability of jackfruit considerably declined. It was highest 7.389 at the 0 day which was decreased to 6.097 at 90 days of storage at ambient condition. The maximum mean (6.965) score for overall acceptability of jackfruit seed chips was recorded in the treatment C2 (2% alum blanched, frying temp.-140 °C, frying time-3 min). The minimum mean (6.500) score was observed in the treatment C1 (Control, frying temp.-140 °C, frying time-3 min). Treatment C2 (2% alum blanched, frying temp.-140 °C, frying time-3 min) shows higher sensory score for texture than C1 (Control, frying temp.-140 °C, frying time-3 min). It was discovered that the interaction between the various treatments and the jackfruit seed chip storage time was not statistically significant. Similar results were seen by Sulaeman *et al*. (2003) [28] in deep-fried carrot chips over the course of storage. For five months, the chips were stored in three distinct environments. The sensory score for overall acceptability of chips stored between 29 and 31 °C and between 89 and 93% relative humidity tended to decrease over time. Similar result was recorded by Akubor and Adejo (2000) [2], In Physicochemical, microbiological and sensory change in stored plantain chips. The chips were stored for 3 months which showed decreasing trend in Overall acceptability score from 4.0 (at 0 day) to 3.5 (at 3rd month).

Table 10: Changes in the sensory attributes of jackfruit seed chips during storage period

Storage duration (Days) (O)	Treatments (C)							
	Colour (sensory)		Flavour (Sensory)		Texture (Sensory)		Overall acceptability	
	C1 (B1F1A2)	C2 (B2F1A2)	C1 (B1F1A2)	C2 (B2F1A2)	C1 (B1F1A2)	C2 (B2F1A2)	C1 (B1F1A2)	C2 (B2F1A2)
0	7.500	8.000	7.500	8.000	7.167	7.611	7.167	7.611
30	7.000	7.750	7.167	7.667	6.722	7.250	6.722	7.250
60	6.500	7.250	6.500	6.750	6.25	6.667	6.25	6.667
90	6.250	7.000	6.000	6.333	5.861	6.333	5.861	6.333
Factor	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%	SE(m)±	C.D. at 5%
Factor (C)	0.069	0.199	0.085	0.243	0.074	0.211	0.113	0.324
Factor (O)	0.098	0.282	0.120	0.343	0.104	0.299	0.16	0.459
Factor (C X O)	0.139	NS	0.169	NS	0.147	NS	0.226	NS

C1: Control (Hot water blanching), frying temp.-140 °C, frying time-3 min
C2: 2% alum solution blanching, frying temp.-140 °C, frying time-3 min
O: Storage period (days)

5. Conclusion

The present investigation concluded that the treatment combination T_3S3 (2% alum solution blanching for 3 min) showed lowest browning index than T_1, T_2 and T_4. On the basis of organoleptic quality for jackfruit seed chips the deep-frying temperature of 140 °C and frying time 3 min were found to be optimal. On the basis of sensory score, the treatment combination B2F1A2 (2% alum solution blanching for 3 min, frying temperature 140 °C and frying time 3 min) showed highest sensory score than others. Also, it is concluded that the jackfruit seed chips could be stored for 3 months in a good acceptable condition at ambient storage condition.

References

1. A.O.A.C. Official method of analysis. Association of Official Analytical Chemists, Washington D.C., USA; 2020.
2. Akubor P, Adejo E. Physicochemical, microbiological and sensory changes in stored plantain chips. Plant Foods Hum Nutr. 2000;55:139-146. https://doi.org/10.1023/A:1008186224120
3. Anonymous. National Horticulture Board. 2024. https://agriexchange.apeda.gov.in/Production/Indiacat/Index. Accessed 14 May 2025.
4. Anonymous. Area and Production of Horticulture crops (2nd Advance Estimates). Department of Agriculture and Farmers Welfare. 2025. http://www.agriwelfare.gov.in/en/Horticulturereports. Accessed 29 Jul 2025.
5. Butool S, Butool M. Nutritional quality on value addition to jackfruit seed flour. Int J Sci Res. 2015;4:2406-2411.
6. Fetuga GO, Ajayi TE, Karim OR. Effect of frying temperature and time on composition and sensory quality of sweet potato crisps. Afr J Root Tuber Crops. 2014;11(1):17-25.
7. FSSAI (Food Safety Standards Authority of India). Manual of methods of analysis of foods, oils and fats. 2016.
8. Garayo J, Moreira R. Vacuum frying of potato chips. J Food Eng. 2002;55(2):181-191.
9. Ghafoor K, Yüksel B, Juhaimi FA, Özcan MM, Uslu N, Babiker EE, *et al*. Effect of frying on physicochemical and sensory properties of potato chips fried in palm oil supplemented with thyme and rosemary extracts. J Oleo Sci. 2020;69(10):1219-1230.
10. Gokhale. Standardization of the process technology for preparation of jackfruit chips and its storage studies. M.Sc. Thesis, Dr. B.S.K.K.V., Dapoli, Department of Post-Harvest Engineering; 2024. p. 49-108.
11. Kishore K. Phenological growth stages of jackfruit (*Artocarpus heterophyllus L*.) according to the extended BBCH scale. Ann Appl Biol. 2018;172(3):366-374.
12. Kita A, Lisińska G, Gołubowska G. The effects of oils and frying temperatures on the texture and fat content of potato crisps. Food Chem. 2007;102(1):1-5.
13. Larmond L. Laboratory methods for sensory evaluation of foods. Canada Department of Agriculture Publication, Ottawa; 1977. p. 1637.
14. Manikantan MR, Sharma R, Kasturi R, Varadharaju N. Storage stability of banana chips in polypropylene-based nanocomposite packaging films. J Food Sci Technol. 2014;51(11):2990-3001.
15. Maurya P, Mogra R. Assessment of consumption practices of jackfruit (*Artocarpus heterophyllus Lam*.) seeds in villages of Jalalpur block district Ambedarnagar (U.P.) India. 2016;2:73-75.
16. Millin TM, Medina-Meza IG, Walters BC, Huber KC, Rasco BA, Ganjyal GM. Frying oil temperature: Impact on physical and structural properties of French fries during the par and finish frying processes. Food Bioprocess Technol. 2016;9:2080-2091.
17. Nagarathna. Vacuum frying of jackfruit bulbs for production of low-fat jack chips. Doctoral dissertation, University of Agricultural Sciences, Bengaluru, Department of Agricultural Engineering; 2017. p. 560-565.
18. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi; 1985. p. 70-72.
19. Park HS, Kim HJ. Quality characteristics of deep fat fried carrots depend on type of frying oil, frying temperature, and time of frying. Korean J Food Sci Technol. 2020;52(1):46-53.
20. Praveenasri B, Priya R, Helen SA. Studies on product from jackfruit seed flour. ICFOST, Hyderabad; 2006. p. 66. Postharvest Biol Technol. 2006;42:228-234.
21. Rajarajeshwari HS, Jamuna Prakash JP. Jackfruit seeds: composition, functionality and use in product formulation. Indian J Nutr Diet. 1999;36(6):312-319.
22. Raleng A, Singh NJ, Sarangi PK, Manojkumar P, Wahengbam A. Standardization of frying time-temperature strategy for enhancing the quality and storability of chayote chips. Appl Food Res. 2022;2(2):100167.
23. Ranasinghe RA, Maduwanthi SD, Marapana RA. Nutritional and health benefits of jackfruit (*Artocarpus*

heterophyllus L.): A review. Int J Food Sci. 2019;V-(1):4327183.
24. Ranganna S. Handbook of analysis and quality control for fruits and vegetables. Tata McGraw Hill, New Delhi; 1986. p. 9-10.
25. Sangma TJT, Suresh CP, Pal P. Standardization of jackfruit chips based on traditional methods practiced by the people of Garo hills, Meghalaya. 2022;1562-1569.
26. Satishkumar. Studies on jackfruit (*Artocarpus heterophyllus* L.) chips production and its storage. Doctoral dissertation, University of Agricultural Sciences, Bangalore, Department of Agricultural Engineering; 2014.
27. Soong YY, Barlow PJ. Antioxidant activity and phenolic content of selected fruit seeds. Food Chem. 2004;88:411-417.
28. Sulaeman A, Keeler L, Giraud DW, Taylor SL, Driskell JA. Changes in carotenoid, physicochemical and sensory values of deep-fried carrot chips during storage. Int J Food Sci Technol. 2003;38(5):603-613.
29. Swami SB, Thakor NJ, Haldankar PM, Kalse SB. Jackfruit and its many functional components as related to human health: A review. Compr Rev Food Sci Food Saf. 2012;11(6):565-576.
30. Teruel MDR, Gordon M, Linares MB, Garrido MD, Ahromrit A, Niranjan K. A comparative study of the characteristics of French fries produced by deep fat frying and air frying. J Food Sci. 2015;80(2):E349-E358.
31. Yadav U, Singh RRB, Arora S. Evaluation of quality changes in nutritionally enriched extruded snacks during storage. J Food Sci Technol. 2018;55:3939-3948.
32. Yodkraisri W, Bhat R. Quality evaluation of deep-fried chips produced from lotus rhizome. Int Food Res J. 2012;19(4):1423.
33. Zehra A. Development of process for shelf-life extension of deep-fried lotus rhizome snacks. Master Thesis. University of Agricultural Sciences and Technology of Kashmir; 2018.