International Journal of Food and Fermentation Technology
Citation: *Int. J. Food Ferment. Technol.*, **14**(02): 675-687, December 2024
DOI: 10.30954/2277-9396.02.2024.14

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

Review Paper

Effect of different Process Parameters and Methods of Jackfruit Chips Preparation on Quality of Chips: A Review

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Paper No.: 309 **Received:** 23-08-2024 **Revised:** 25-11-2024 **Accepted:** 07-12-2024

ABSTRACT

An established method for preparing jackfruit chips can assist the business owner in preserving both the consistency and quality of their goods. Economic stability will be attained via preserving the quality of the output. It was vital to create a system that makes sense commercially and that all business owners should use. This review's primary goal is to investigate various jackfruit chip preparation methods. There are several methods available for preparing jackfruit chips based on the preferences of the consumer. Of all those procedures, a few are easy to utilize and a few are financially viable.

Keywords: Jackfruit, preserving, consumer, business owners, preparation

Jackfruit Chips is more delicious snack food prepared in each an every home before rainy season in Konkan region, which improves the palatability while eating due to its crunchy and crispy sound. The jackfruit chips are eaten by all age group peoples. It's an indigenous snack food product which was most acceptable by all the peoples. Jackfruit is found in large amount in the Konkan region but the commercial utilization of jackfruit is very less as compared to the other fruits. It is necessary to utilize the more jackfruit on commercial scale. It is very easy to prepare jackfruit chips, but the standardization of the process of jackfruit chips preparation is important to maintain its quality and uniformity while processing. Chips are snack food made form thinly sliced fruits or vegetables that are fried (Saputri *et al.* 2022). There are different methods of frying that going to be used while preparation of jackfruit chips. The new technologies are evolving and are going to discuss in this review. Study of new emerging technologies is important for utilization of it in the production process.

Process of Jackfruit chips Preparation

The general process of jackfruit chips preparation includes washing and cleaning of jackfruit, cutting of jackfruit, removal of bulb, deseeding of bulb, slicing of bulb and then frying in any frying oil. Mostly Coconut oil was preferred for frying. The atmospheric frying is generally conducted because it is easy process and small quantity bulb required for frying.

Different methods of jackfruit chips Preparation

1. Vacuum Frying Process
2. Deep Fat Frying Process
3. Drying

How to cite this article: Gokhale, A.M. and Swami, S.B. (2024). Effect of different Process Parameters and Methods of Jackfruit Chips Preparation on Quality of Chips: A Review. *Int. J. Food Ferment. Technol.*, **14**(02): 675-687.

Source of Support: None; **Conflict of Interest:** None

Vacuum Frying

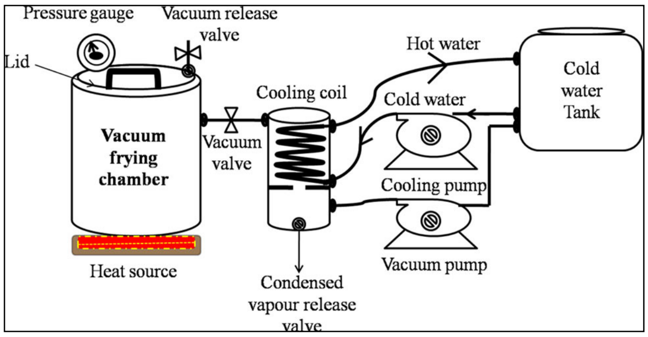

Fig. 1: Vacuum frying system
(Pandey and Chauhan, 2019)

Vacuum frying is nothing but frying in oil below the atmospheric pressure with lower boiling point and lower frying temperature. Vacuum frying is more acceptable in this era, because frying is done at low temperature with less oil uptake. Working pressures much below atmospheric pressure, ideally below 6.65KPa - 7KPa are required for the process of vacuum frying (Maity *et al.* 2015; Moreira, R.G., 2014). Vacuum fryer composed of an electric motor, frying basket, condenser, vacuum pump, centrifuge, vacuum chamber and store oil can (Fan *et al.* 2007; Ayustaningwarno *et al.* 2018; Pandey *et al.* 2020; Moreira, 2014).

According to Moreira, 2014, The process of vacuum frying involves heating of oil; next, the product must be loaded into the basket and the lid closed; next, the vessel must be evacuated to a pressure of roughly 1.33 kPa before the products are submerged in the oil; fourth, the product must be fried until the desired moisture level is reached; fifth, the basket must be removed from the oil and the samples must be de-oiled using centrifugation or another method; and finally, the vessel must be pressurized and the lid opened. The vacuum frying system decreases the pressure inside the chamber to generate airtight conditions, which lowers the liquid's boiling point. Low pressure makes it possible to lower the food's moisture content and frying medium's boiling point, which stops harmful chemicals from forming. There are other benefits to frying with less oxygen available, such as decreased oxidation of fat and a decrease in browning processes and acrylamide generation (Pandey *et al.* 2020). There were no. of experiments conducted to study vacuum frying process while preparation of jackfruit chips. Fig. 1 gives the information about the system of vacuum frying. Also the Table 1 gives the information about the vacuum frying carried out in jackfruit chips.

Effect of vacuum frying on properties of quality jackfruit chips

1. Moisture Content

The jackfruit chips that George *et al.* (2019) created were vacuum-fried. The low moisture level of the VF-jackfruit chips was caused by the first drying process used to remove moisture from the jackfruit slices. The moisture content for dried slices was 0.472 %. Drying before vacuum frying can improve more moisture removal as compared to other pretreatments like blanching. After vacuum frying moisture content get reduce. Maity *et al.* (2018) investigated how preconditioning affected jackfruit chips. Pre-partial drying at 60 °C to a final moisture content of around 60% and pre-freezing at -20 °C for 16 hours were the two pretreatments that were employed. The pre-partial drying reduced more amount of moisture after vacuum frying. In the vacuum frying process boiling point of water becomes lower due to reduced pressure causes rapid removal of free water when temperature reaches to the boiling point of water. Maity *et al.* (2014) investigated how the temperature and length of vacuum frying affected the chip quality. The highest moisture removal occurs at 100°C temperature for period of time even if chips fried at 80°C and 90°C temperature for same period of time. Nagarathna, S.B. (2017) conducted research on vacuum-frying jackfruit bulbs to produce low-fat jack chips. Two distinct vacuum frying pressures (640 mmHg and 400 mmHg) were used, together with three distinct temperature ranges (80, 90, and 100 degrees Celsius) and three distinct durations (15, 20, and 25 minutes, respectively). When jackfruit chips were fried for 20 minutes at 90°C, under 400 mmHg of vacuum pressure, contains very less moisture 4.17% than the chips fried at 640 mm Hg (4.71%).

Table 1: Vacuum Frying of jackfruit bulb

Sl. No.	Oil used	Treatment	Temperature ºC	Centrifugation	Inference	References
1	**Rice bran to coconut oil ratio 80:20**	Thickness: 0.5 mm Blanching : 1,2,3, min Drying : 105°C for 3hr	Temp.100°C and 110°C, time: 18 and 20 min, pressure: 9 kPa and 12 kPa	5min for 1000 rpm	Less oil content (20.73%), hardness (1.04 N), water activity (0.473), moisture content (0.481%), colour values *L** (70.18), *a** (2.71), and *b** (35.41) are obtained at 100 ºC and 9 kPa pressure for 20 minutes.	George *et al.* (2019)
2	**Vegetable oil**	Thickness: 4×0.5 × 0.5 cm. 1)Pre-partial drying : 60 °C, 60% moisture content 2)Pre-freezing at -20 °C for 16 hours	90 °C and 100 mbar pressure.	8 min 500 rpm	Pre-frozen produces the greatest results for crispness with high porosity and low bulk density, while pre-partial drying performs well for lower moisture content.	Maity *et al.* (2018)
3	**Vegetable oil**	Thickness: 4 × 0.5 × 0.5 cm	Time : 25, 30, and 20 minutes Temperatures: 80ºC, 90 °C, and 100 °C	8 min for 500 rpm	At 90 °C for 25 minutes gives best results.	Maity *et al.* (2014)
4	**Refined sunflower oil**	Thickness: 15×4mm Blanching: 60°C with 1% potassium metabisulphite	Pressure: 640 mmHg and 400 mmHg Temperature: 80 ºC, 90 °C, 100 ºC	5min for 500 rp	Chips fried at 90°C for 20 minutes, under 400 mmHg gives beast results.	Nagarathna, S. B. (2017)

Table 2: Deep fat frying of jackfruit bulb

Sl. No.	Oil used	Treatment	Temperature	Slice : oil ratio	Inference	References
1		0.5 to 0.6 cm salt concentrations (T1-3.2%, T2-2.8%, T3-2.4%, and T4-2%			2.0 % of salt concentration moisture percentage (4.75%), carotenoid content (0.32 mg/100), and oil content (33.89%)	Maheswari and Valsan (2020)
2	Vegetable oil	4cm2cm 70°C for an hour and 60°C for the following six hours, blanching at 90°C for 10 to 15 minutes with 0.1% KMS (2 kg solution/ kg of bulb),	170°C for ten minutes	1:2.5 to 1:4		Sunil (2020)
3	Palm oil	4/5cm1.5/2cm blanched for 10 minutes at 95°C0.1% KMS preservative solution (2 kg solution/kg of bulb).	150°C, 160°C, and 170°C for 13, 12, 10 min respectively		170 °C 10 min	Molla *et al.* (2008)
4	Sunflower oil	15×40 mm) Hot water blanching with 0.1% KMS solution for 5 min	Temperature: 160,180 and 200°C; Time: 6, 7 and 8 min	1:4	7 minutes at 180°C	Satishkumar (2014)
5	Coconut oil	1cm×5cm first stage, 45 days; second stage, 65 days; third stage, 75 days; and fourth stage, 95 days	165°C for 7min		Out of all the phases, the first one was beneficial since it showed a lower acrylamide concentration Fruit sugar levels also increased, indicating a positive link with the development of acrylamide during deep-frying.	Shamala *et al.* (2019)
6	Refined Cooking Oil	0.6-0.8 cm breadth thickness Sun Drying + Frying Blanching + Sun drying + Frying	150°C and 170°C		Blanching with sun drying and then frying at 150°C temperature gives the best results	Sangma *et al.* (2022)

Table 3: Drying of jackfruit bulb

Sl. No.	Treatment	Temperature	Inference	References
1	5×1.5×1.5 cm	60°C temp., 1.2m/s velocity, 12% relative humidity dry till get moisture content of 5%	Instant controlled pressure drop assisted freeze drying (FD-DIC) best method	Yi *et al.* (2016)a
	Instant controlled pressure drop assisted hot air drying (AD-DIC),			
	instant controlled pressure drop assisted freeze drying (FD-DIC),	1) 0.1kPa pressure at temperature-56°C 2)25°C drying till get 50% moisture content db 3) 90°C for 10 min 3kPa pressure 4) Vacuum drying 60°C for 2.5hr		
	freeze drying (FD)	-40°C		
2	2-4mm size Blanching (T1), Blanching + CaCl2(0.5%) (T2), Blanching + Citric Acid (0.5%) (T3), Blanching + Ascorbic Acid (0.4%) (T4),	55°C for 6-8hr till get moisture content of 9 %	Ascorbic Acid (0.4%) (T4)	Patil *et al.* (2014)
3	Sugar solution concentrations, 55 °B and 60 °B 0.5% KMS and 1% citric acid for 4 hrs	Dried at 60°C 29 hr	55 °B sugar solution and 60 °C drying temperature were employed gives best results	Swaroopa *et al.* (2016)
4	6cm length × 3 cm width × 0.5 cm thickness 0.3% (w/v) citric acid, 1% (w/v) potassium metabisulfite Diping in % (w/v) of $CaCl_2$ for 30 min slices to solution ratio 1:2 (w/v).	Freeze-drying (Freezing -30 °C for 3-4 h for 4-6% moisture content; 100-300 Pa and temperature at 50 °C for 20 hrs), Hot air-drying (60 °C with 2 m s-1 air velocity; 5-7 % MC%), Combination-dehydration (decrease in freeze-drying phase (i.e. 10, 8, 6, 4 h) increase in the hot air drying phase (i.e. 2, 4, 6, 8, 10, 12 h))	1.38 % w/v CaCl2, 28.2 °brix blanching concentration, and 5.2 min Blanching time. Combination-dehydration of Freeze Drying for 6 h with Hot Air Drying for 8 h was gives best quality jackfruit bulb slices.	Saxena *et al.* (2015)

5	20×20 mm Diping in KMS solution (0.3-0.6 %) for 40 min., Diping in potassium sorbate (0.3-0.5 %) for 10 min., Blanching of slices at 90°C for 2-3 min, Cooling in ice water , Soaking in sugar solution 30-60°B,	Heating for 15-30 min, Drying (55-60°C) until 12-15 % MC %	50°B sugar solution was observed to be best for preparation of dehydrated jackfruit bulb slices	Chowdhury *et al.* (2022)
6	3×1.5×1.5 cm -40°C stored for 24hrs, 90°C equilibrated for 5 min EPD with 3kPa pressure, vacuum for 65°C till get moisture content of 7%		FD-EPD best	Yi *et al.* (2016)b
	Hot air Explosion puff drying	65°C 1.2m/s velocity		
	Freeze dry Explosion puff drying	1)-55°C 2) 25°C		
	Infrared Explosion puff drying	75°C 1125W/m^2 0.48, 0.60 and 0.90 kW lights wavelengths 3.15, 3.10, 1.40 μm		
	Microwave Explosion puff drying	2.2 W/g power load ratio		
	Vacuum Explosion puff drying	65°C, 40Pa vacuum		

2. Oil content

According to Nagarathna, S.B., 2017 more amount of FFA (Free Fatty Acid) was found in 640 mm Hg than the 400 mmHg of vacuum pressure. After frying the FFA content increases. Maity *et al.* (2014) investigated that the as the frying time increases with increase in temperature the oil absorption also increases. According to Maity *et al.* (2018) during the vacuum frying process moisture diffusion gradient is form that causes the formation of hydrophobic nature and oil sticks to food surface when removed from the fryer the pressure inside the food sample and outside area changes causes absorption oil. After vacuum frying the oil content of the food was increased. Oil absorption depends upon the preconditioning. Less oil absorption occurs in pre-partial drying of jackfruit bulb slices. According to George *et al.* (2019) less oil content was observed in untreated vacuum fried jackfruit chips.

3. Texture

According to George *et al.* (2019) pretreatments affects the texture of chips. Less amount of breaking force was required for chips pretreated with freezing. Freezing increases the loss of moisture rapidly with oil absorption that forms crispy structure. Maity *et al.* (2018) found that pre-frozen chips have high crispness as compared to pre-partial drying process. According to Maity *et al.* (2014) at initial period of frying time due to high amount of moisture content high breaking force is required, after some time of frying water hydrolysis occurs; which requires less amount breaking force. Nagarathna, S.B. (2017) found that at lower pressure more amount breaking force was required as compared to higher pressure.

4. Colour

Nagarathna, S.B. (2017) found that as the temperature and frying time increases the dull colors were formed while at lower temperature of frying bright colors were formed. According to Maity *et al.* (2014) as frying time increases the value "L" goes on deceasing and the value "a" increases with increase in frying time and "b" value also goes on decreasing with increase in temperature and frying time. At higher temperature "b" decreases rapidly due to loss of carotenoid content. Maity *et al.* (2018) found that the same result "L" values were deceased, "a" values increased and "b" values decresed. According to George *et al.* (2019) here the control sample produce light colour chips while the pre-dried chips gives more dark color which was not desirable. The high amount of yellowness was found in frozen pretreated vacuum fried chips.

2. Deep Fat Frying

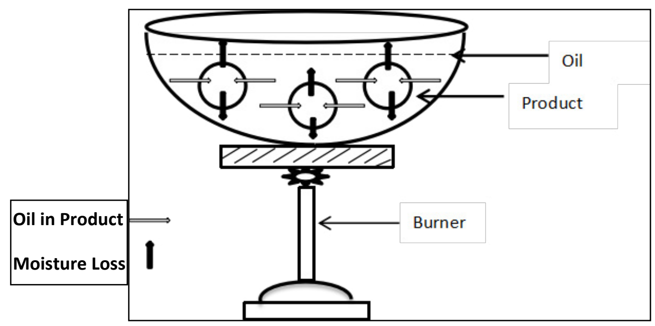

Fig. 2: Deep Fat frying of chips
(Gokhale and Swami (2024)

Deep fat frying is another method of food preservation. Deep fat frying removes the moisture from the food and store the food for longer period. Deep fat frying is nothing but atmospheric frying process which involves frying of fruits, vegetables, tubers and other food products. Deep fat frying is a traditional process of frying. Deep fat frying involves the heating of oil at desired temperature, submerging of slices of food material in heated oil and then removed from pan after completing the whole frying process. The general temperature of deep fat frying involves 120°C - 200°C temperature range of frying (Oke *et al.* 2018; Bordin *et al.* 2013; Pedreschi and Zuniga, 2009; Orthoefer and List, 2007; Bouchon, P., 2009). Deep fat frying is simultaneous method of heat-mass transfer that causes various physicochemical changes in frying food material (Devi *et al.* 2021; Alvis *et al.* 2009). Convective heat transmission from the frying medium to the product's surface and conduction heat transfer within the food are the two ways that heat transfer happens between food and frying oil.

There are two types of mass transfer involves one is water and another is oil. As shown in Fig. 2 oil penetrated inside the food material and moisture losses from food material when desired temperature reach. Complete oil absorption occurs when the food material is removed from the oil and placed aside for cooling. Time and temperature of frying these are two properties that are interdependent with each other, when temperature of frying increases the time required for frying decreases. (Bouchon, P. 2009; Asokapandian *et al.* 2020). There were many studies occurs in deep fat frying of jackfruit chips. The Table 2 gives the information about the deep fat frying carried out in jackfruit chips.

Effect of deep fat frying on properties of quality jackfruit chips

1. Moisture content

The value addition of jackfruit through the manufacture of chips was investigated by Maheswari and Valsan (2020). During the six-month storage period, they employed various salt concentrations (T1-3.2%, T2-2.8%, T3-2.4%, and T4-2%). More salt concentration gives less moisture content and low amount of salt concentration shows high moisture content. According to Molla *et al.* (2008), jackfruit chips were packaged and kept for two months. After frying the moisture content goes on decreasing. According to Shamala *et al.* (2019), the chemical composition of jackfruit chips varies with different stages of maturation, which has an impact on the product's quality. When deep-frying chips, the amount of acrylamide grows along with the size of the fruit. The four stages—first stage, 45 days; second stage, 65 days; third stage, 75 days; and fourth stage, 95 days—are chosen based on the day of fruit setting. As the maturity stage of jackfruit increases the moisture content also increases.

2. Oil content

According to Maheswari and Valsan (2020), as the oil absorption capacity decreases with increase in salt concentration. According to Molla *et al.* (2008), as frying temperature increases the oil absorption also increases. At 170°C temperature oil content found was 45%. Shamala *et al.* (2019), investigated that as the maturity stage increases the oil absorption also increases after deep fat frying.

3. Colour

The value addition of jackfruit through the manufacture of chips was investigated by Maheswari and Valsan (2020). As the capacity of oil absorption decreases with an increase in salt concentration, although the concentration of carotenoids content (0.32 mg/100), continuously rises. According to Molla *et al.* (2008), as the temperature rises the light yellow colour moves toward the dark shade. According to Shamala *et al.* (2019), total carotenoid content found in jackfruit bulb increases with increase in maturity stage.

4. Texture

Maheswari and Valsan (2020) found that chips' crispness is correlated with their moisture level, and it reduced as the moisture content of the chips increased.

3. Drying

Drying is nothing but process of removal of water from the food material with the help of heat. Drying involves different methods i.e., sun drying, solar drying, freeze drying, air drying, hot air drying, solar drying, infrared drying, microwave drying, drum drying, spray drying, vacuum drying, osmotic drying, foam mat drying, impingement drying, acoustic drying, explosion puffing drying, hybrid dryer and oven drying (Inyang *et al.* 2017). From all the above mention methods some of them were used for preservation of jackfruit bulb chips. The Table 3 gives the information about the drying carried out in jackfruit chips.

In order to preserve jackfruit chips, Yi *et al.* (2016) investigated the creation of many innovative combination drying techniques. Instant controlled pressure drop assisted hot air drying (AD-DIC), instant controlled pressure drop assisted freeze drying (FD-DIC), and freeze drying (FD) are all included in this. The technique that produced the greatest results for a high expansion ratio (119%), the best color (ΔE, 6.5), and the best texture (hardness 42 N, crispness 19) was the FD-DIC. The FD-DIC was more well accepted overall. Here the explosion puff drying id nothing but Phase change theory and the gas's hot-pressing effect serve as the foundation for explosion puffing. The product undergoes a textural change at high temperatures of about 100 °C and high pressures of average 0.4 MPa, which encourages the product's inner moisture to evaporate spontaneously during a quick pressure release to atmospheric pressure and gives the food a porous structure (Kaur *et al.* 2023).

Colour "L" values goes on down from 59 to 56 in FD-DIC, from 59-52 in AD-DIC and for FD "L" value goes up. Also the "a" values goes increase in FD-DIC and AD-DIC but in FD it is goes down. "b" value for all chips goes down. From all the values it was observed that the chips goes towards dark colours.

Texture the less amount of braking force was required for FD whereas highest force required for AD-DIC. Also the FD dried chips shows less crispness while FD-DIC shows more crispness.

Moisture Less moisture content was found in FD-DIC and AD-DIC but in FD dried chips more moisture found.

The impact of pre-treatment on the physicochemical makeup of dried jackfruit chips was investigated by Patil *et al.* in 2014. Blanching (T1), Blanching + $CaCl_2$ (0.5%) (T2), Blanching + Citric Acid (0.5%) (T3), Blanching + Ascorbic Acid (0.4%) (T4), and Control (T5) were the five treatments that were applied. T4 treatment was the best of all the above treatments; it received an overall acceptance score of 6.91 for storage lasting 60 days.

Moisture Content there was a less moisture content found in T4 treatment as compared to other treatment

β-Carotenoid Here also T4 shows higher carotenoid content

Osmotic dehydrated jackfruit crisps were developed and evaluated by Swaroopa *et al.* (2016). Two distinct sugar solution concentrations, 55 °B and 60 °B, were used; of the two, 55 °B produced the best results. As a result, 55 °B sugar solution and 60 °C drying temperature were employed. Osmotic dehydration is nothing but the phenomena where water is transferred from a solution with a lower solute concentration to one with a greater concentration across a semi-permeable membrane, creating an equilibrium on both sides of the membrane (Tiwari, R.B., 2005). As an osmotic agent for Osmotic dehydration, a variety of solutes are employed, including fructose, maize syrup, glucose, sodium chloride, and sucrose. At the first removal of water occurs through dehydration process with use of osmotic agent then product placed in a dryer for removal of water and to maintain the desired moisture content in food product to improve its storage period (Azura, E and Beristai, C.I., 2002).

Another method of jackfruit chips preparation was explosion puff dried jackfruit chips by Yi *et al.* (2016), where five different treatments were conducted i.e., Hot air Explosion puff drying (65°C 1.2m/s velocity), Freeze dry Explosion puff drying (1.-55°C 2. 25°C), Infrared Explosion puff drying (75°C, 1125W/m^2, 0.48, 0.60 and 0.90 kW lights wavelengths 3.15, 3.10, 1.40 μm), Microwave Explosion puff drying (2.2 W/g power load ratio) and Vacuum Explosion puff drying (65°C, 40Pa vacuum). The drying time of each method was depends on pre-drying method.

Colour

It was observed that "L" for all the treatments were less than fresh samples and higher in FD drying as compared to fresh sample. This was due to Freeze drying contribute towards the white colour appearance. AD-EPD shows light brown shade while all other treatment shows golden yellow colour which was desirable characteristic.

Texture

AD dried chips shows more braking force of 63.9 N, where the other treatments i.e., AD-EPE, FD-EPD, IR-EPD, MV-EPD, and VD-EPD requires less breaking

Table 4: Effect of frying on physicochemical properties of raw jackfruit bulb slices after frying

Sl. No.	Composition	Young fruit Swami *et al.* (2012)	Vacuum Fried Chips (Saputri *et al.* 2022)	Osmotically Dehydrated Jackfruit Slices (Chowdhury *et al.* 2022)
1	Water %	76.2 to 85.2	3.68 ± 0.24	7.38±0.03
2	Protein %	2.0 to 2.6	2.51 ± 0.26	—
3	Fat %	0.1 to 0.6	15.06 ± 2.02	—
4	Carbohydrate %	9.4 to 11.5	72.07 ± 2.40	—
5	Fiber %	2.6 to 3.6	5.48 ± 0.12	—
6	Total sugars %	—	—	30.90±0.1
7	Reducing sugar %	—	—	7.85±0.03
8	Ash %	0.99 ± 0.21 (Saputri *et al.* 2022)	2.80 ± 0.18	0.52±0.02
9	Acidity %	—	—	0.11±0.01
10	Energy (Kcal/g)	46.5-61.8	433.86	425.44±7.22

force. From that it was observed that AD dried samples shows less crispness and EPD dried samples shows more crispness. But FD dried chips shows more crispness and porous structure also maintain cell structure without collapsing parenchyma cells. FD-EPD shows more acceptable porous structure with crispiness. Also more colour retention occurs in FD-EPD.

Jackfruit bulb crisps were prepared by using combination drying methods (Saxena *et al.* 2015). Here three different methods were carried out 1) Freeze-drying (Freezing -30 °C for 3-4 h for 4-6% moisture content; 100-300 Pa and temperature at 50 °C for 20 hrs), 2)Hot air-drying (60 °C with 2 m s-1 air velocity; 5-7 % MC%), 3) Combination-dehydration (decrease in freeze-drying phase (i.e. 10, 8, 6, 4 h) increase in the hot air drying phase (i.e. 2, 4, 6, 8, 10, 12 h)). Combination-dehydration of Freeze Drying for 6 h with Hot Air Drying for 8 h was gives best quality jackfruit bulb slices. Combination-dehydration shows shrinkage % 30.5, Rehydration ratio 2.34, Hardness 23.98 (N), Crispness 5.08 (N), L- Value 73.79, ΔE 20.9, Over All Acceptability score 7.17. High amount of lightness was observed in freeze drying but in Hot air drying high amount of darkness was observed. Freeze dried crisps shows lesser hardness and low crispness as compared to Hot Air Drying.

Dehydrated jackfruit bulb slices were prepared by Chowdhury *et al.* 2022. Jackfruit bulb slices were soaked in sugar solution 30-60°B after giving pretreatments. From all the concentrations 50°B sugar concentration gives best results.

The Table 4 gives information about the physicochemical properties of unripe mature jackfruit bulbs, vacuum-fried jackfruit chips, and osmotically dehydrated jackfruit slices. From the above table, it was observed that after value addition of jackfruit through vacuum frying and osmotic dehydration, the physicochemical properties of jackfruit bulbs changed. In both methods, moisture content% was reduced, but in vacuum frying, more amount of water loss was observed as compared to osmotically dehydrated jackfruit slices. It was due to vacuum frying being carried out under high pressure and temperature during the frying process that heat and mass transfer occurred that caused loss of moisture. Also, there was a slight increase in protein content observed during the vacuum frying process. After the vacuum frying process, the fat content% was also increased. The increase in fat content of chips was due to the absorption of oil during heat and mass transfer processes. Also, there was an increase in carbohydrate content% of vacuum-fried jackfruit chips observed; it may be due to links between the constituents of the water molecule being broken during the frying process. The hydrates that are formed between water molecules and other molecules that have atoms of carbohydrates are what is responsible for this rise (Saputri *et al.* 2022). Fiber content present in raw jackfruit bulbs was 2.6 to 3.6% and was increased up to 5.48 ± 0.12% in vacuum frying of jackfruit chips. According to Asp and Bjorck (1992), the formation of an amylose-lipid complex was partly responsible for this increase in fiber content. In vacuum frying of jackfruit chips from the above table, it was observed that ash content % was increased, and there was a slight decrease in ash content% in osmotically dehydrated jackfruit slices. All that was left of the food substance after the water had been removed was the mineral content known as ash. During the frying process, water is removed from the food sample (Saputri *et al.* 2022). More amount of energy is increased after frying the material also after the osmotic dehydration of jackfruit slices. This increase in energy of food material is due to the absorption fat that increases the intake of calories.

CONCLUSION

The quality of the product is determined by several elements during the manufacture of jackfruit chips. Certain processes include drying the food prior to that, while others involve deep-fat frying and pressure-frying. The chips' flavor, color, crispness, and oil content can all be impacted by that process. In the vacuum frying the more colour retention occurs. Very less amount of moisture content and oil content occurs in vacuum frying technology. Also during the vacuum frying process texture was good with more porous structure and crispness. All the desirable characteristics found in vacuum frying. But equipment cost is more. Also it has limited production capacity with loss in potential flavour. In the deep fat frying also the less moisture occurs with rich in flavour and colour that was formed during heat-mass transfer. According to studies more amount of oil content found in chips after frying. But it has requires less quantity of oil at a time of frying. But it provides more crispy structure. Chips that are produced with the help of drying can retain the more amount nutrients. But the use of explosion puff drying and instant control pressure drop assisted freeze drying are ideal methods but more costly. From that it was observed that each method has its own positive and negative effect. The best method is depends on the desired product characteristics, production costs and consumer preferences.

Also the all the methods that are performed during the storage of jackfruit chips may affect the physicochemical properties of jackfruit chips. In vacuum frying process it was observed that moisture content reduced, fat content increased, protein content increased, carbohydrate content increased, fiber content was also increased. Energy in vacuum fried chips and osmotically dehydrate jackfruit slices was found to be increased.

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