Project report

On

“Chemical , sensory, and microbial assessments of leathers developed from *Artocarpus heterophyllus* Lam.(Jackfruit)”

Submitted to:

Dr. Nizam Uddin

Associate Professor & Head

Department of Nutrition & Food Engineering

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Submitted by:

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Date of submission:

24th September ,2022

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CERTIFICATE APPROVAL

This is certify that the research work embodying the results reported in this project "Chemical, sensory, and microbial assessments of leathers developed from *Artocarpus heterophyllus* Lam.(Jackfruit)" submitted by Md Mostafizur Rahman has been carried out under our collective supervision of Nasima Akter Mukta and co-supervision of Prof. Dr. Md. Bellal Hossain in Department of Nutrition and Food Engineering, Daffodil International University. It is further certified that the research work presented here is suitable for submission for partial fulfillment of the degree Bachelor of Science in Nutrition and Food Engineering**.**

……

Dr. Nizam Uddin
Associate Professor and Head
Department of Nutrition & Food Engineering
Daffodil International University.

……

Nasima Akter Mukta
Assistant Professor
Department of Nutrition and Food Engineering,
Daffodil International University.

LETTER OF TRANSMITTAL

24th September 2022
To,
Dr. Nizam Uddin
Associate Professor and Head
Department of Nutrition & Food Engineering
Daffodil International University

Subject: Submission of Project report

Dear Sir,
I would like to take this opportunity to thank you for the guidance and support you have provided me during the course of this report "Chemical, sensory, and microbial assessments of leathers developed from *Artocarpus heterophyllus* Lam.(Jackfruit)". Without your help, this report would have been impossible to complete.
To prepare the report I collected what I believe to be most relevant information to make my report as analytical and reliable as possible. I have concentrated my best effort to achieve the objectives of the report and hope that my endeavor will serve the purpose. The practical knowledge and experience gathered during report preparation will help me in my future professional life. I request you to excuse me for any mistake that may occur in the report despite of my best effort.

I would really appreciate if you enlighten me with your thoughts and views regarding the report.

I therefore, would like to place this report to your judgment and suggestion. Your kind advice will encourage me to perform better planning in future.

Sincerely Yours,

Md Mostafizur Rahman
ID no: 191-34-852
Department of Nutrition and Food Engineering,
Daffodil International University

LETTER OF AUTHORIZATION

24th September 2022
To,
Dr. Nizam Uddin
Associate Professor and Head
Department of Nutrition & Food Engineering
Faculty of Allied Health Sciences
Daffodil International University

Subject: Declaration regarding the validity of the Project Report.

Dear Sir,
This is my truthful declaration that the project report "Chemical, sensory, and microbial assessments of leathers developed from *Artocarpus heterophyllus* Lam. (Jackfruit)". I have prepared is not a copy of any thesis report previously made any other students.

I also express my honestly confirmation in support to the fact that the said thesis report has
neither been used before to fulfill my other course related not it will be submitted to any other person a authority in future.

Sincerely yours

Md Mostafizur Rahman
Department of Nutrition and Food Engineering,
Daffodil International University

DECLERATION

This Dissertation entitled “Determination of “Chemical, sensory, and microbial assessments of leathers developed from *Artocarpus heterophyllus* Lam. (Jackfruit)” is being submitted to the Department of Nutrition and Food Engineering, Faculty of Allied Health Sciences, Daffodil International University, Dhaka-1207. Bangladesh as a part of partial fulfillment of the requirements for the degree of Bachelor of Science in Nutrition & Food Engineering. This project report is unique and done by Md Mostafizur Rahman’s authentic hard work.

Supervised by

Nasima Akter Mukta
Assistant Professor
Department of Nutrition & Food Engineering
Daffodil International University

Co-Supervised by

Prof. Dr. Md. Bellal Hossain
Associate Dean
Department. of Nutrition and Food Engineering
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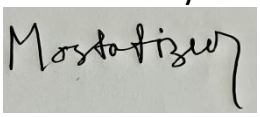
Submitted by



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Abstract

Artocarpus heterophyllus Lam. (jackfruit) is a seasonal fruit and is a source of nutrients. This study aimed to prepare leathers from *Artocarpus heterophyllus* Lam. (jackfruit) at variable temperatures and compositions to find the optimum product in terms nutrients, ease of process ability and microbial stability. Samples were prepared with sugar and without sugar at the three different temperatures (60, 65 and 70) ℃. Six samples named as S1 (without sugar, 60°C), S2 (with sugar, 60°C), S3 (without sugar, 65°C), S4 (with sugar, 65°C), S5 (without sugar, 70°C), and S6 (with sugar, 70°C) were analyzed for total moisture, ash, protein, fat, fiber, sugar, reducing sugar, titratable acidity, and for microbial stability. The results revealed that nutritional properties of jackfruit leather were influenced by the composition as well as drying temperature. The highest total soluble solids (14.42%), reducing sugar (9.76%), and titratable acidity (1.72%) were observed for S6. The moisture content (18.29%), total sugar (18.50%), reducing sugar (9.15%) were higher in sample S2. Effect of Jackfruit drying temperature and leather composition showed variation in the total soluble solids (TSS) content and pH of Jackfruit leathers. S6 is more microbial stable then S1. Reddish brown is the Color of leather, S3 and S6 two are perfect in color but S1 and S2 were less attractive. Leather sample 4 and sample 6 showed Taste and provide great taste. Texture of S1 and S2 were less attractive then other samples. Chewiness of leathers in turn of most to less S6,S5,S4,S3 but S2,S1 were typically same. As far as storage ability was concerned it was observed that drying by higher temperature given more storage ability then that of the lower temperature. The composition of leather was observed as responsible for higher storage ability. All the Samples except S1 were found to be stored as edible for a longer period of time (around two months) at normal temperature storage condition. From jackfruit pulp can produce many types of product like beverage,squash,nectar, wine, chips, jam and also Many other products.

Chapter-1

Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.) is one of the most popular, delicious and indigenous fruits in Bangladesh. It was originated in Indian subcontinent and now is widely cultivated in the tropics of both hemisphere. It is grown in Bangladesh, India, Mayanmar, Malaysia, the Philippines, Thailand and to some extent in Brazil and Queensland of Australia. It is cultivated in Bangladesh from the time of unknown period, grown throughout the country in highland and homestead areas where rain and flood water do not stand.(morton, julia -19 april 2016)(love,ken -2016) Jackfruit is considered as a national fruit of Bangladesh and it ranges the second position in yield among the fruits of the country In Bangladesh, the jackfruit occupies an area of 25,110 hectares and its annual production is 4,59,500 tons, and it is 22% of total fruit production from all over the country. (BBS, 2007)

There is no one definition of the term functional food. It is used in many contexts, including references to technological advances, food marketing, and food regulatory norms. This term has already been defined several times and there is still no unified accepted definition for this group of foods . In most countries, there is no legal definition of the term and drawing a border line between conventional and functional foods is challenging even for nutrition and food experts.(BBS,2007)

The edible pulp is 74% water, 23% carbohydrates, 2% protein, and 1% fat. The carbohydrate component is primarily sugars, and is a source of dietary fiber. In a 100-gram (3+$^1\!/_2$-ounce) portion, raw jackfruit provides 400 kJ (95 kcal), and is a rich source (20% or more of the Daily Value, DV) of vitamin B_6 (25% DV). It contains moderate levels (10-19% DV) of vitamin C and potassium, with no significant content of other micronutrients.(Silver,mark april-2016)(mwandambo,pascal december 2016)

Every year a lot amount of jackfruit is produced in Bangladesh. This fruit is highly perishable and seasonal Marketing of fruit in the season becomes difficult and the farmers do not get a desirable price of the commodity. If the excess fruits in the season are preserved by any means ensuring the quality, consumers would have the taste of this seasonal fruit all the year round. Again the processed fruits could be exported to earn foreign currency Drying of agricultural products is still the most widespread preservation technique At present dried fruit is becoming more and more an alternative to marketing fresh fruits as the demand of high quality dried fruits is increasing all over the world.

A few years ago in rural are jackfruit acts as main seasonal fruit in summer season and a lot of people satisfy their hunger by this fruit. But the reason of its highly Perishable activity lot amount of jackfruit were rotten. For this reason preserving of jackfruit can makes profit and take tastes preserved food product in another season.

It is manufactured by dehydrating a fruit puree into a leathery sheet. The leather is eaten as a confection or cooked to give a certain Leathers are made from a wide variety of fruit including mango,banana,pineapple to increase the Processing and storage stability days to months or years.

The diversified product of jackfruit leather would be one of the new items of snack in the country. On the other hand, jackfruit leather drying and processing industries may generate an employment opportunity. In Bangladesh the rural people who are mostly illiterate can prepare jackfruit leather by drying jackfruit juices. Lack of proper amenities like proper handling, time of exposure of the product to the high environmental temperature may contributes significantly to the loss of quality. Besides sufficient knowledge about scientific and hygienic drying method is also important to produce quality product.

Therefore, a study on drying of leather of three types of jackfruit, their chemical, sensory and microbial assessment of leathers development is essential to produce diversified product of jackfruit.

The present work has been undertaken with the following objectives-

1.To study the chemical assessment of leather drying in three different temperature.
2.To study the chemical assessment of leather in two different composition.
3.Sensory evaluation of leather in field level.
4.To determine the storage ability of prepared leather.
5. To determine the activity of microorganisms in different composition and when dried in different drying temperature.

Chapter-2

Review of Literature

The jackfruit is an evergreen perennial tree. It is one of the most important tropical fruits but highly perishable. In the past, there was little study on making diversified product of jackfruit in the country Making jackfruit leather is one of the alternative example of diversified product that protects jackfruit from wastage and would be the future storage for consumption The studies on jackfruit leather, it's preparation and chemical characteristics are very limited, However, a review of the available information related to the present study is given below.

Sensory assessments of Jackfruit Leather

The drying temperature (60,65 and 70 ℃) can effect on the color,taste,smell, quality of leather and also the storage ability of dried leather.

The composition of leather also very effective on physical characteristics. Sugar increase color,flavour, taste and storage ability.salt increase taste and citric acid increase storage ability and provide long shelf life.(Diamante,2014)

Table 1: Chemical composition of jackfruit (chayon goswami -2016)

parameters	% of chemical composition
Moisture content	78%
TSS	20%
Ash content	0.88%
Acidity	0.25%
Vitamin C	8mg/100g
Reducing sugar	6.53%
Non-reducing sugar	8.40%
pH	5.2-6.2

Health benefits

Jackfruit is a good source of fiber, so it could help us feel fuller for longer and help keep our bowel movements regular.The natural chemicals in jackfruit may help prevent these sores from forming inside our stomach. our body digests and absorbs jackfruit more slowly than some other foods. That means our blood sugar won't rise as quickly as it might when we eat other fruits. One study found that jackfruit extract made it easier for people with diabetes to control their blood sugar.The potassium in this tropical fruit could help lower our blood pressure, which can help stave off heart disease, stroke, and bone loss.The high amounts of vitamin C in jackfruit may help protect our skin from sun damage. we need plenty of that nutrient to keep our skin firm and strong.Phytonutrients, like those found in jackfruit, are natural compounds that might have cancer-fighting benefits, such as preventing cancer cells from forming in our body. (Kathleem M. Zelman - june 14,2021)

Without pulp jackfruit seed and another parts are also important and nothing is waste in jackfruit.seeds are also use as food and the jackfruit peel used as animal food. But which parts rotten used as compost in field.

Chapter-3

Methods and Materials

3.1 Collection of Raw material (Jack fruit)

The research conducted on processed Jackfruit in Bangladesh to estimate the proximate composition. The experimental sample were collected from Mirpur kacha bazar, Dhaka.

Sample: Jackfruit

This sample collected as fresh and ripe as possible to use in NFE lab for preparation and analysis.

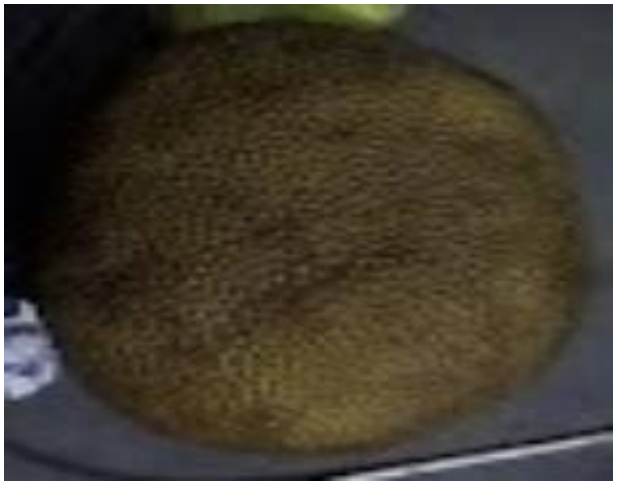


Figure 1: Whole ripe Jackfruit

3.2 Preparation of samples:

Experimental procedure
Pre-drying procedure are important in order to prepare the commodity in a suitable form for drying.Ripe jackfruit was collected to optimum color and sweetness.Ripen jackfruit provide yellowish color and highly sweetness.

Jackfruit are collected from Mirpur kacha bazar ,Dhaka.Before here jackfruit leather was invented in India but research not gone too far.

The process of continuous as procedure theory (Diamate 2014)

3.2.1 Fruit harvesting and bulb collection:

Collected ripen Jackfruit cut by knife and bulb separate from main fruit by hand picking.Among the bulbs good colored and ripen bulbs were separated for the experiment.

3.2.2 Steam Blanching:

After collecting good colored and ripen seedless bulb take weight and smoke blanched for 10 minutes and let cool.

3.2.3 Juice making:

Blanched bulbs were blended in blender and added sugar, salt and citric acid in different four combination and blend for few minutes before it's looks perfectly smashed.Collect the juice in a pot and placed at cool temperature.

3.2.4 Drying of juice:

Pre-heat the dryer what temperature need for drying. Two trays were taken for different two sample ,and three different temperature .Total six samples mark as S1,S2,S3,S4,S5 and S6 Two combination of sample uniform in two tray in three different drayer temperature and note them.after marking them take trays to dryer for six hours.

In this process the sample dried six hours at 60^{o}C after blanched and blend the pulp.then preserve in ziplock bag (two samples) when the blend sample changed to leather form.

In this process the sample dried six hours at 65^{o}C after blanched 10 minute and blend the pulp.then preserve in ziplock bag (two samples) when the blend sample changed to leather form.

In this process the sample dried six hours at 70^{o}C after blanched 10 minute and blend the pulp.then preserve in ziplock bag (two samples) when the blended sample changed to leather form.

Figure 2: Jackfruit leather

3.3 Determination of chemical composition on jackfruit leather:

3.3.1 Determination of moisture:

Determination of moisture by using moisture analyzer is easy way to determine moisture from solid or semi solid samples.Before sampling preparing the analyzer need to start.actually three different sample give three different results.it works on 120^{o}C and 3 different sample shows 3 different time and 3 different % of moisture they are hold in.

Materials for analyzing moisture:

1. Moisture analyzer
2. Aluminium foil
3. Sample
4. Weight balance

Figure 2: Determination of Moisture

3.3.2 Determination of Ash :

The crucible take into the oven at 105^{o}C for 2 hours. Then cool the crucible into the desicator ,and after cool the take weight the crucible without sample and with sample(note them both). The jackfruit leather sample (2 grams) were minced, weighted & ignited into the crucible. Then it transferred into the muffle furnace held at the dark side of the furnace at a rate of 600-620 degree Celsius for 6-8 hours. Until the residue was white. Finally, the percentage of the ash content was calculated.

%Ash= (weight of white dry ash÷weight of sample)×100

Procedure of the ash estimation:

a) Taken the small pieces of the sample.
b) Sample weight taken.
c) Heated on gas stove up to burn the sample.
d) Kept it on the furnace for 6-8 hours.
e) Sample after furnace ash weight recorded

Figure 3: Determination of ash

3.3.3 Determination of crude proteins:

Proteins play important role in our body,which are mainly very complex nitrogenous substances formed by the sub unit of amino acid through peptide linkage. The crude proteins from jackfruit leather determined by micro kjeldhal method (pearson ,1999). The basic principle of the method involves the conversion of nitrogenous protein into ammonium sulphate (NH4SO4). When boiled with sulphuric acid (H2SO4).Ammonium sulphate was distillation with sodium hydroxide (NaOH) gave ammonia (NH3) which was absorbed in boric acid solution containing methyl red. The amount of sample (2) ml with catalyst (ammonium sulphate) boiled by 20 ml 98% of H2So4 at (100+)^{o}C till a clear substance.

Preparation of sample solution:

The digestion solution was made into 40% of NaOH solution. Take 100 ml of volumetric flask. Take 40 gm of NaOH in volumetric flask and add 40ml distil water and shake ,then added more 20 ml distil water and shake again. After solid NaOH fully changed into liquid form than added water from the 100ml sign in the volumtric flask.In the preparation of 4% of boric acid ,make 50 ml of boric acid solution with distil water. Take 2 gm of boric acid and fill with distil water till 50ml.make 100ml of 0.1N HCL and transfer into titration burette.

The digestion solution was made into 100ml in volumetric flasks with distilled water 10ml of sample,20ml NaOH solution was transferred in a micro kjeldhal distillation unit. The solution was kept for about 45 minutes .Distillation was collected in access of 30 ml 4% boric acid solution till 100 ml. Then mix few drops of methyl red indicator and was titrated by o.1N HCl solution. After titration, the initial green color changes into pink color.

Calculation of Protein percentage (%) :

The percentage of nitrogen in the sample calculated by the following formula

% N2=(volume of o.1N HCL used×Normality of HCL×Acid Factor×Molecular weight of Nitrogen)÷(sample weight×10).

For the routine purpose of the % of protein in the sample was calculated by multiplying the % of N2 with an traditional factor 6.25 for the fruits. And dilution factor.
%of crude protein: % of nitrogen×Traditional factor×Dilution factor.

Estimation of protein % :

a. Pouring the sample in the kjheldal round flask.
b. Adding H2SO4 (98%) and catalyst.
c. Kjeldhal machine for titration 6 hours till clear solution.
d. After digestion the sample changed into distillation flask.
e. Add indicator and Titration with HCL(0.1N).
f. Color changes to pink indicate the end of the titration.

Figure 4: Determination of protein (Digestion)

3.3.4 Determination % of crude fat content:

Preparing of sample:

First of all, we have to dry the product and remove moisture in order to facilitate entry of the organic solvent, because moisture restricts the entry of organic solvent. Then size reduction is there to increase the surface area and due to it, there is larger exposed surface. After this, we go for acidic hydrolysis which helps in breaking of protein fat emulsion and increases the availability of fat for the solvent. Furthermore, we can collect the solvent by distillation by using these Requirements:

- Weighing balance
- Soxhlet apparatus

- Drying oven
- Thimble
- Heating mantle
- Glass rod
- Desiccator with silica gel
- Petroleum ether (Boiling temperature 60°-80°c)
- Cotton plugs

Procedure:
First of all, rinse all the glass apparatus by petroleum ether and dry it in the oven at 102°c and after removing it keep in the desiccator.Weigh 5 gram of grounded and dried sample and place it in the thimble.Place the thimble in the soxhlet extractor. Take a 250ml round bottom flask and clean it and fill the flask with 90 ml petroleum ether.Place the whole setting on a heating mantle and allow the petroleum ether to boil.Continue the extraction process for several hours, almost 6+ hours.Remove the condensing unit from extraction unit and allow the sample to cool down. Finally, it removes all the lipid.Collect almost all the solvent after distillation.Place the sample in the oven and after removing it place in the desiccator.Take the weight of the sample.As a result, we get a defeat sample.

Calculation:
Sample weight -P
Volumetric flask (Empty dry) -W1
Volumetric flask (after extraction oil) -W2
% of crude fat -- (W2-W1)/P×100

This method is an efficient method to extract all the fat present in the food. Hence it is used in oil extraction units for better recovery of oil. This method is also applied to the deoiled cake which is collected from screw impellers rather than high-pressure expression. It is also used in the analysis of fat present in the sample.

Figure 5: Determination of Fat

3.3.5 Determination of crude fiber :

Crude fiber is determined by using of digestion and neutralization in food material. The difference of residue weight and ash content of residue is amount of crude fiber.

*Take 250 ml volumetric flask and Prepare 250 ml of 0.128M (98%) H_2SO_4 solution with distil water.take the solution in a conical flask then added 5 gm off jackfruit leather (paste). Boil the sample with solution at 105^oC 20+ min over hotplate.

*Then filter that in a moslin cloth,and wash the conical flask using hot water and also the sample. Transfer the sample to another conical flask and added 250 ml of 0.313M NaOH solution.and Boil it again using hotplate then filter again in moslin cloth.

*Then collect it in a pre-weighted dry crucible.then dry in oven 2 hours at 130^oC.cool in desiccator and take weight and note it. Then take it to the muffle furnace at 600 degree celcius for 2 hours and transfer it to the desiccator for cool.then take weight and note it.

Calculation:

Weight of sample- Ws

Weight of dry residue-W1

Weight of residue ash-W2

% of crude fiber- $\{(W1-W2)\div Ws\} \times 100$

3.3.6 Determination of Total Suspended Solids:

Weight 30 gm of jackfruit and blend with 100 ml of water.blend the sample as they are crushed perfectly. Then take them into a 300 ml measuring cylinder ,wash the blender and fill the cylinder till 300 ml. Shake the cylinder and divided the sample into three different 500 ml flask. Fill the 100ml sample and 400 ml distil water total 500ml of cylinder.then take filter paper weight and filter each 500ml of solution differently.then take 3 different filter paper with sample and dry them into oven

dryer at 105℃ for at least 2 hours.then take the weight of filter paper.take weight and note.

Calculation:
Weight of sample -W1

Weight of dry residue-W2

% of Total Suspended Solid- (W1-W2)×100

3.3.7 Total Soluble Solid Determination:

Now these days Using hand refractometer determine soluble solid presence in food is easy.after preparing the sample then take it to the refractometer then the refractometer shows the reading of soluble solid presence in food.It depends on how much presence in fruit and how much we added when preparation.

3.3.8 Determination of pH:

Using pH meter determine pH is easy now a days.it also shows temperature and in which temperature shows which pH.I have done jackfruit leather pH after making sample paste from leather form.Its done by digital pH meter.

3.3.9 Determination of acidity of jackfruit leather:

Titratable acidity was determined following the methods analytical lab procedure.Two gram leather was taken in a blender machine and homogenized with distilled water. The blended material was then filtered and transferred to a 100 ml volumetric flask and the volume was made up to the mark with distilled water. A portion of liquid from the volume was centrifuged.

Titration:

Ten ml solution was taken in 100 ml conical flask. A few drops of 1% phenolphthalein solution (indicator) was added to the flask and titrated with 0.1 N NaOH solution from burette until a light pink colour appeared and persist for 15 seconds. The

titration was done for 3 times for accuracy. Per cent titrable acidity was calculated using the following formula :

% Titratable acid= (Tx NxVxEx100)/(V_2 x W x1000)
Where
T = Titre
N = Normality of alkali
V_1 = Volume made up
V2 = Volume of sample taken for estimation
E = Equivalent weight of malic acid
W = Weight of sample for estimation

Before titration → After titration

Figure 6: Determination of titration of Acidity

3.4 Microbiological tests for jackfruit leather: (Leguizaman delgado-2019)

3.4.1 Colony form unit:

Requirements:

Agar powder, Nutrient agar , Lab thermometer, Distilled water, Glass stir rod,Heat resistant hand protection, Boiling mixture (autoclave), Sterile Petri dish, Beaker/flask, Shaker, Petri dish, Incubator

Procedure:

Measure the recommended amount of agar and distilled water in to a clean, sterile flask or beaker.Autoclave all the instruments at the temperature of 121 degree celcious for 30 minutes.After 30 min put them out and cool them down in laminal hood.Take sample and make paste then take weight and take in a test tube.shake it until mix well. Make sample solution as 10^-2,10^-3,10^-4,10^-5,10^-6, as well as make 6 petri dish for colony form.Mark the petri dish and sampling the petri dish.and seal them.Took them to the incubator for 72 hours.Count colony form every 24 hour.

Calculation:
Dillution factor =10×times of solution decreasing volume in number.

The CFU/ml can be calculated using the formula:

cfu/ml = (no. of colonies x dilution factor) / volume of culture plate

Bacteria/ml = (130) x (10^6) = 1.3 × 10^8 or 130,000,000

Figure 7:Determination of Coloniforming Unit

3.4.2 Gram staining:

At the lab, a medical laboratory scientist smears or spreads the sample on glass microscope slides. These slides are known as smears. They then apply a series of stains to the smear to perform a Gram stain.

The Gram staining process includes four basic steps, including:

1.Applying a primary stain (crystal violet).

2.Adding a mordant (Gram's iodine).

3.Rapid decolorization with ethanol, acetone or a mixture of both.

4.Counter staining with gram safranin

Chapter-4

Result and discussion:

Local, English, Scientific name of Jackfruit:

This project done for find out nutritional value,chemical composition of jackfruit leather and to find out characteristics of jackfruit leather when it have different composition with dry in different temperature.

The English name, local name, scientific name of jackfruit leather are shown in table

Table 2: The English name, Local name, and scientific name of jackfruit grown in Bangladesh.

English name	Jackfruit
Bangla/Local name	কাঁঠাল
Scientific Name	*Artocarpus heterophyllus* Lam.

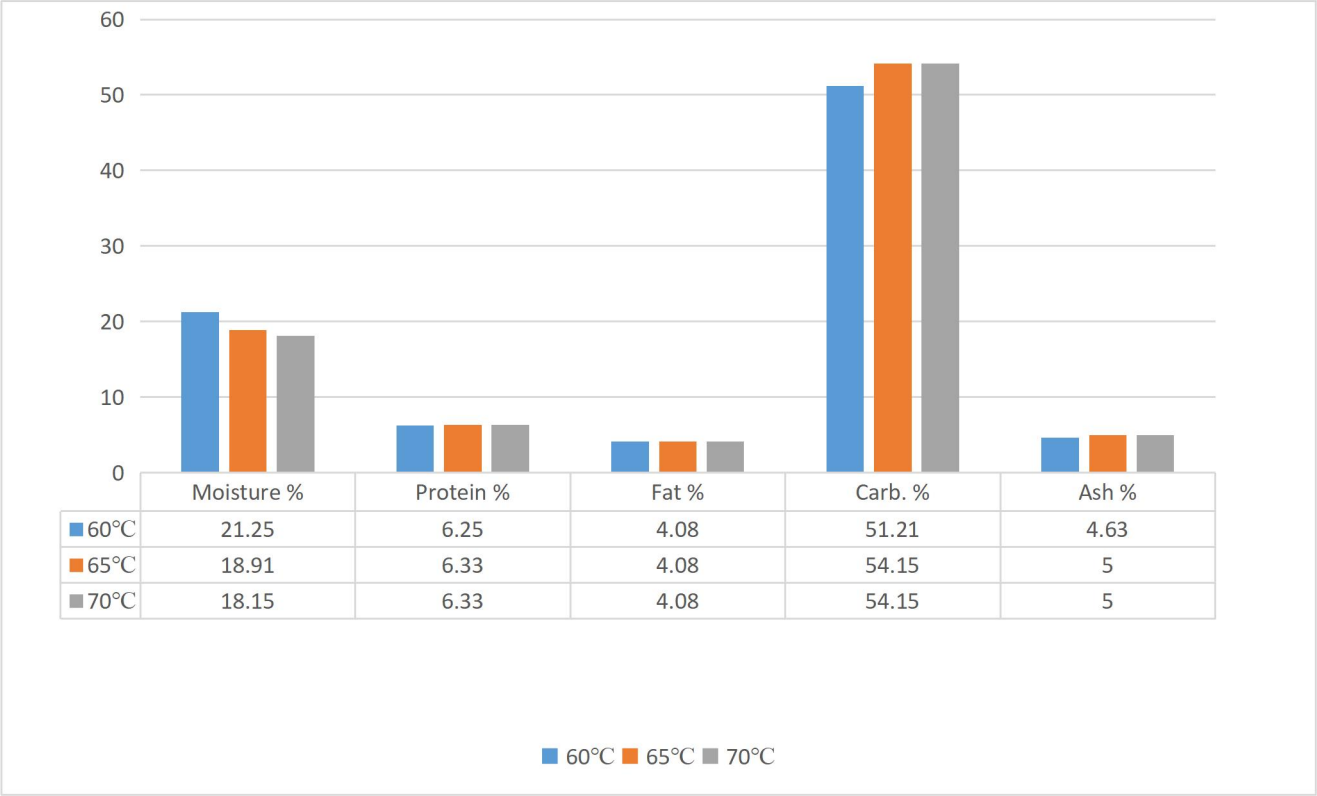
Table 3: Proximate Analysis of jackfruit leather. sample without sugar (S1,S3 and S5)

Parameters	60℃	65℃	70℃
Moisture%	21.25	18.91	18.15
Protein%	6.25	6.34	6.34
Carbohydrate %	51.21	54.15	54.15
Fat %	4.08	4.08	4.08
Ash %	4.63	5.00	5.00
Energy (Kcal/100gm)			

Table 4: Proximate Analysis of Jackfruit leather. Sample with sugar (S2,S4 and S6)

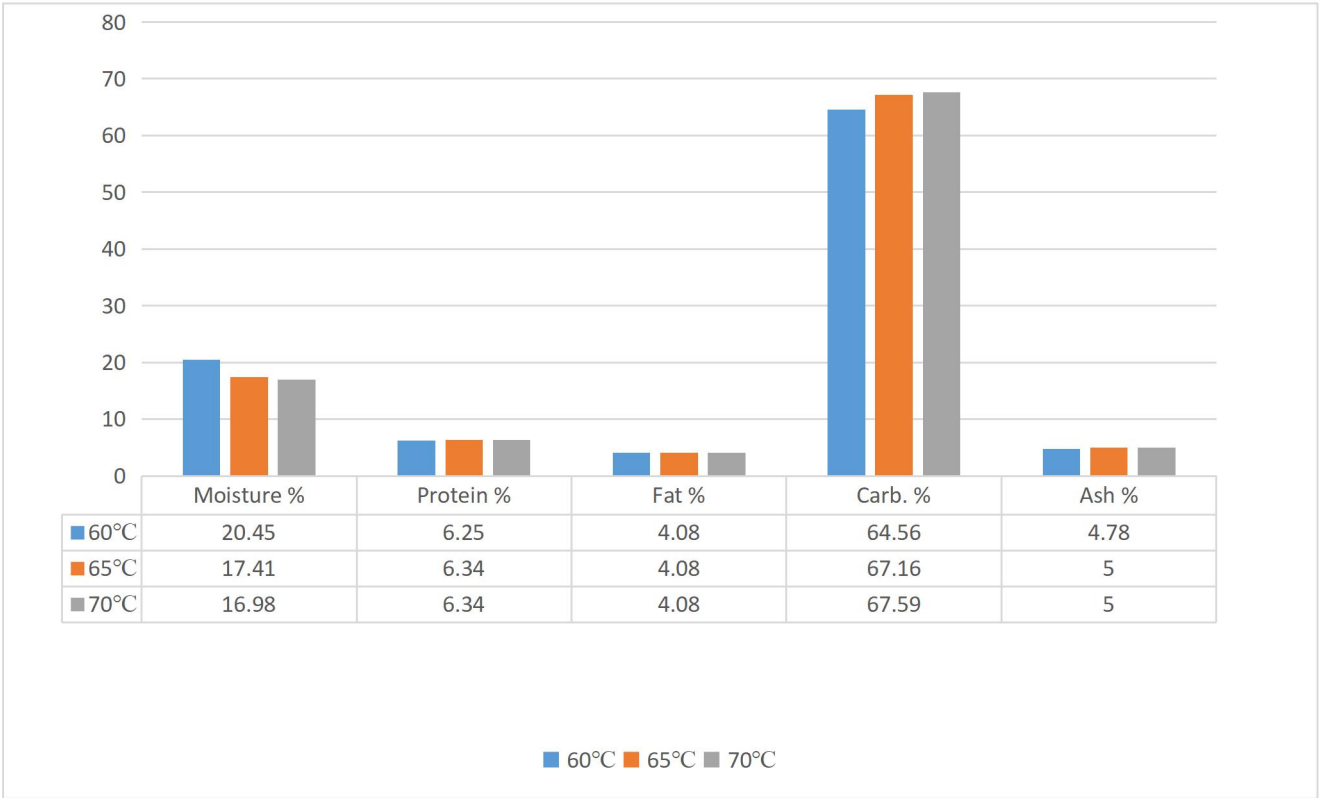
Parameters	60℃	65℃	70℃
Moisture%	20.45	17.41	16.98
Protein%	6.25	6.33	6.34
Carbohydrate %	64.55	67.17	67.59
Fat %	4..08	4.08	4.08
Ash %	4.65	5.00	5.00
Energy (Kcal/100gm)	319.97	330.75	332.49

Column Chart for leather S1,S3 and S5:



	Moisture %	Protein %	Fat %	Carb. %	Ash %
60℃	21.25	6.25	4.08	51.21	4.63
65℃	18.91	6.33	4.08	54.15	5
70℃	18.15	6.33	4.08	54.15	5

Column Chart for leather S2,S4 and S6:



	Moisture %	Protein %	Fat %	Carb. %	Ash %
60℃	20.45	6.25	4.08	64.56	4.78
65℃	17.41	6.34	4.08	67.16	5
70℃	16.98	6.34	4.08	67.59	5

4.1 Moisture content :

The moisture content of Jackfruit leather at 60℃,65℃ and 70℃ were 20.46%, 17.41% and 16.98% respectively (Table).It proved that 3 different types of drying Temperature given different proportion of moisture content.

4.2 Protein content:

The protein content of Jackfruit leather at 60℃, 65℃ and 70℃ drying temperature were 6.25%, 6.33% and 6.34% respectively (Table). It showed that Jackfruit have been containing medium amount of protein content .

4.3 Fat content :

The fat content of Jackfruit leather at 60℃, 65℃ and 70℃ drying temperature were 4.08%, 4.08% and 4.08% respectively (Table). So it proved that Jackfruit have a small amount of fat content.

4.4 Ash content:

The Ash content of Jackfruit leather at 60℃,65℃ and 70℃ -drying Temperature were 4.88%, 5.00% and 5.00 % respectively (Table).

4.5 Carbohydrate content:

The Carbohydrates content of Jackfruit leather at 60℃, 65℃ and 70℃-drying temperature were 64.56℃%, 67.17% and 67.60 % respectively (Table)

4.6 Energy content:

The energy content of white cabbage powder by oven drying , solar drying, freeze drying method were 319.98 kcal/100gm, 330.76kcal/100gm and 332.50 kcal/100gm respectively(Table)

4.7 Crude fiber:

The amount of crude fiber depends on which types of jackfruit used to make leather.the amount of crude fiber in modhupur gala jackfruit leather is 5.515%.Which is the lowest fiber content from other types of jackfruit.

4.8 Total suspended solids:

Total suspended solids (TSS) are defined as solids in water that can be trapped by a filter. To measure TSS, the water sample is filtered through a pre-weighed filter.The amount of total suspended presence in jackfruit leather is very high. It is average 17.75 % from total weight.

4.9 Total Soluble solids :

Total soluble solid of jackfruit leather 14.2%,14.42% and 14.64% is the percentage from three different sample from three different temperature.The average of TSS is 14.42%.

4.10 pH:

pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water.The pH in jackfruit leather was 4.26 and 4.53 differentiate by addition of citric acid and with out citric acid.

4.11 Titratable acidity :

The effect of titratable acidity was 1.69% in jackfruit leather. This result of titratable acidity is titrate three different sample collect from three different temperature.there was a significant combination effect between drying temperature in relation to titratable acid content.the titratable acidity was highest in 1.72% in drying temperature of 60 degree celcius at 8 hours.And the lowest one was 1.64% in drying temperature 70 degree celcius and 5.30 hours.

4.12 Colony form (CFU) :

Cfu/ml = 96×10^-6

=9.6×10^-5 or 96/1000000.

4.13 Gram staining:

Showed pink color absorbing gram positive bacteria which are not bad for body. that means no harmful bacteria presence.

4.14 Sensory Evaluation:

Samples are known as S1 and S2.and dried at three different temperature.
Sensory data collect from 25 students and 5 teacher and all marks are out of 10.

9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like or dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely.

Table 4: Data analysis for Color (Reddish Brown) of dried leather of jackfruit.

Panelist no	60℃		65℃		70℃	
	S1	S2	S3	S4	S5	S6
1	5	5	8	8	10	8
2	5	6	9	9	10	9
3	6	7	8	8	8	8
4	6	6	9	9	9	9
5	6	5	9	9	9	9
6	4	4	8	8	8	8
7	4	5	9	9	9	9
8	5	6	9	8	9	8
9	6	6	8	8	8	8
10	7	7	9	8	9	8
Mean	5.4	5.7	8.7	8.5	8.7	8.5

Table 5: Data analysis for Taste for dried jackfruit leather:

Panelist no	60℃		65℃		70℃	
	S1	S2	S3	S4	S5	S6
1	4	4	8	8	9	8
2	5	4	9	7	9	7
3	5	4	9	8	9	8
4	5	4	9	8	10	8
5	5	4	9	8	9	8
6	6	5	10	9	10	8
7	5	5	9	7	9	8
8	5	4	10	9	10	9
9	4	4	8	8	9	8
10	6	4	9	8	9	8
Mean	5	4.2	9	8	9.3	8

Table 6: Data analysis for flavour of dried jackfruit leather:

Panelist no	60℃		65℃		70℃	
	S1	S2	S3	S4	S5	S6
1	6	6	9	9	9	9
2	7	6	10	9	10	9
3	6	6	9	7	9	8
4	5	5	9	8	9	8
5	6	6	10	9	10	9
6	6	5	10	9	10	9
7	6	5	8	8	9	8
8	5	5	10	9	10	9
9	7	7	10	10	10	10
10	5	5	10	9	10	10
Mean	5.9	5.6	9.5	8.7	9.6	8.9

Table 7: Data analysis for chewiness of dried jackfruit leather:

Panelist no	60℃		65℃		70℃	
	S1	S2	S3	S4	S5	S6
1	6	6	9	9	9	9
2	7	7	10	9	10	10
3	6	5	9	8	10	9
4	7	6	9	9	9	9
5	6	6	8	8	9	8
6	6	6	9	9	9	9
7	7	7	9	8	9	8
8	7	6	8	8	10	9
9	7	6	10	9	10	9
10	7	7	9	9	9	9
Mean	6.6	6.2	9	8.6	9.4	8.9

Table 8: Data analysis for texture of jackfruit of dried jackfruit leather:

Panelist no	60℃		65℃		70℃	
	S1	S2	S3	S4	S5	S6
1	4	4	9	9	9	9
2	5	5	8	8	9	9
3	5	4	8	8	9	9
4	4	4	9	8	9	7
5	4	5	8	8	8	9
6	5	4	8	8	9	9
7	4	4	10	9	10	9
8	4	4	9	8	9	9
9	4	4	9	9	9	8
10	4	4	9	8	9	8
Mean	4.3	4	8.7	8.3	9	8.6

Chapter -5

Conclusion

Artocarpus heterophyllus Lam. (jackfruit) is a seasonal fruit and is a source of nutrients. This study aimed to prepare leathers from *Artocarpus heterophyllus* Lam. (jackfruit) at variable temperatures and compositions to find the optimum product in terms nutrients, ease of process ability and microbial stability. Samples were prepared with sugar and without sugar at the three different temperatures (60, 65 and 70) ℃. Six samples named as S1 (without sugar, 60^{o}C), S2 (with sugar, 60^{o}C), S3 (without sugar, 65^{o}C), S4 (with sugar, 65^{o}C), S5 (without sugar, 70^{o}C), and S6 (with sugar, 70^{o}C) were analyzed for total moisture, ash, protein, fat, fiber, sugar, reducing sugar, titratable acidity, and for microbial stability. The results revealed that nutritional properties of jackfruit leather were influenced by the composition as well as drying temperature. The highest total soluble solids (14.42%), reducing sugar (9.76%), and titratable acidity (1.72%) were observed for S6. The moisture content (18.29%), total sugar (18.50%), reducing sugar (9.15%) were higher in sample S2. Effect of Jackfruit drying temperature and leather composition showed variation in the total soluble solids (TSS) content and pH of Jackfruit leathers. S6 is more microbial stable then S1. Reddish brown is the Color of leather, S3 and S6 two are perfect in color but S1 and S2 were less attractive. Leather sample 4 and sample 6 showed Taste and provide great taste. Texture of S1 and S2 were less attractive then other samples. Chewiness of leathers in turn of most to less S6,S5,S4,S3 but S2,S1 were typically same. As far as storage ability was concerned it was observed that drying by higher temperature given more storage ability then that of the lower temperature. The composition of leather was observed as responsible for higher storage ability. All the Samples except S1 were found to be stored as edible for a longer period of time (around two months) at normal temperature storage condition. From jackfruit pulp can produce many types of product like beverage,squash,nectar, wine, chips, jam and also Many other products.

Chapter-6

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