

**Report  
on  
Production and Cost Analysis of Locally  
Processed Frozen French fries on Trial**



Department of Agricultural Marketing and Cooperatives  
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- 1) Sujan Pradhan, Principal Post Production Technologist, National Post Harvest Centre, Paro
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## 1. Introduction / Background

Frozen French fries is processed potato product that is pre-cut, partially fried, and frozen for convenience. In Bhutan, 71.82 MT of processed potatoes worth 9.61 million Ngultrum was imported in 2024 to meet the demand from restaurants, hotels, and food outlets. This dependence on imports highlights both the popularity of the product and the limited availability of locally processed alternatives. Developing local production of frozen French fries would not only reduce imports but also add value to locally produced potatoes and support the growth of Bhutan's agro-processing sector. Bhutan produced a total of 37,778 MT of potatoes in 2024.

Currently the demand for French fries in Bhutan is either met through import of frozen French fries or own preparation. A survey was conducted in Thimphu from 3-4 August 2025 by engaging the importers, retailers and restaurants who deal with frozen French fries as part of their business. A total of 15 business entities were surveyed using a semi-structured questionnaire: three potato frozen French fries importers, three retail sellers, and nine restaurant owners selling French fries.

*Table 1:Quantity and price of imported frozen French fries by three major wholesalers of Thimphu*

Sl. No.	Name of Business	Import Price from India (Nu./Kg)	Selling Price to Retailers/Restaurants (Nu.)
1	Wholesaler A	156	190
2	Wholesaler B	155	170
3	Wholesaler C	155	194

*Source: Survey by MDD, DAMC in August, 2025*

The wholesalers reported paying Nu. 155 - 158 per Kg of frozen French fries from India and sells to the restaurants and retailers ranging from Nu. 170-194 per Kg (Table 1).

The importers, retailers, and restaurants reported better quality and longer shelf life as the key reasons for using the imported frozen French fries. The majority of the respondents expressed willingness to buy locally processed frozen French fries provided the products meet the required quality and is available consistently. So this product trial was initiated to study the feasibility of local frozen French fries production.

## 2. Objectives of the Trial

- To assess feasibility of local frozen fries production
- To analyze production costs and recovery rates
- To compare with market alternatives

### 3. Materials and Methods

#### 3.1 Raw Materials Used

The product samples of frozen French fries were developed using local potato varieties: *Yusi-Chip-1* and *Yusi-Maap* sourced from Chapcha under Chhukha Dzongkhag, and another *Yusi maap* variety obtained from Jew village in Paro.

Table 2: Quantities of raw material (Potato) sourced

SN	Potato and Variety	Quantity (Kgs)	Source
1	<i>Yusi-Chip-1</i>	44.64	Lobneykha, Chhukha
2	<i>Yusi-Maap</i>	50.63	Lobneykha, Chhukha
3	<i>Yusi-Maap</i>	53	Jew, Paro

#### 3.2 Processing Steps

The process for production of frozen French fries follows several key steps;

a. Cleaning, Grading and Sorting

The raw material (potato) are first cleaned to remove any external debris, sorted to discard the damaged, diseased and greened potatoes and graded ensure optimal and uniform size.



Figure 1: Cleaning, sorting and grading of Potatoes

### b. Peeling and Cutting

The potatoes are then peeled, washed and cut into strips having an average length of 2.5 inches.



Figure 2: Peeling and cutting of potatoes

### c. Blanching and Freezing

The strips are then blanched at 90°C for five minutes and immediately cooled in ice water to stop the cooking process. This is followed by dehydration for five minutes to remove surface moisture, partial frying at 180°C for one-minute, quick freezing at -20°C.



1. Blanching at 80°C for 5 minutes

2. Keepin in ice water to stop cooking the process.

3. Dehydration for 5 minutes to remove surface water

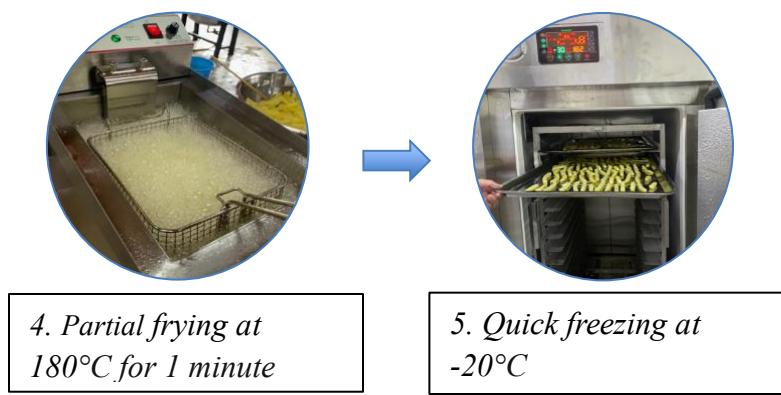


Figure 3: Blanching and Freezing process

#### d. Packaging

The processed strips are then packaged into low-density polyethylene (LDPE) plastic and stored at  $-18^{\circ}\text{C}$  in the deep freezer.



Figure 4: Packaged processed fries

#### 4. Recovery Rate

In this research, the Recovery rate of the frozen French fries from the raw potato was obtained.

Recovery rate is the percentage of final weight of product output from the initial raw material weight as shown below;

$$\text{Recovery rate} = \text{Final Frozen French fries Wt.} / \text{Initial. Wt.} * 100$$

Table 3: Yield and Recovery of Frozen French fries by Potato Variety

Potato Variety	Stage	Weight (Kg)	Recovery rate (%)
<i>Yusi-maap</i> (Chhukha)	Raw potatoes	50.63	
	After cleaning and sorting	38.30	
	Final Frozen fries	18.39	<b>36.32%</b>
<i>Yusi-maap</i> (Paro)	Raw potatoes	53	
	After cleaning and sorting	41	
	Final Frozen fries	22.72	<b>42.87%</b>
<i>Yusi-Chip 1</i>	Raw potatoes	44.64	
	After cleaning and sorting	39.15	
	Final Frozen fries	19.27	<b>43.2%</b>

The recovery rates varies slightly across the varieties, with *Yusi-Maap* (Paro) recording 42.87%, *Yusi-Chip 1* yielding 43.2%, and *Yusi-Maap* (Chhukha) achieving 36.32%.

The overall recovery rates are relatively low and can be attributed to several factors. Some of the potatoes exhibited greening, likely resulting from inadequate postharvest storage that exposed the tubers to light. These greened potatoes were discarded during sorting, as they are unsuitable for

processing due to the presence of glycoalkaloids, which impart a bitter taste and pose health risks. Moreover, some portions of tubers exhibited black heart, a physiological disorder caused by restricted oxygen supply during growth or storage, leading to darkened centers that compromise processing quality and flavor. Furthermore, a considerable amount of shredding occurred during cutting because of irregularly shaped tubers, which further contributed to product loss and reduced overall recovery.

## 5. Dry Matter Content

The dry matter content of a potato is the percentage of its total weight that is solid material, excluding water.

*Table 4: Dry matter content of the three potato varieties*

Variety	Dry matter	Remarks
<i>Yusi-maap (Chhukha)</i>	17.60%	Low
<i>Yusi-chip 1</i>	17.94%	Low
<i>Yusi-maap (Paro)</i>	19.90%	Low

The dry matter content of the three potato varieties, *Yusi-maap(Chhukha)*, *Yusi-chip 1*, and *Yusi-maap (Paro)* was found to be 17.60%, 17.94%, and 19.90% respectively as shown in Table 4. All values are considered low for the production of frozen French fries, as an ideal dry matter content generally ranges between 20% and 24%. Potatoes with low dry matter tend to produce fries that are soft, oily, and less crispy after frying, which negatively affects product quality and consumer preference.

## 6. Cost Analysis

### 6.1 Cost of Production

The cost of production was determined by considering all associated expenses, including the procurement of raw materials, labor costs, miscellaneous expenses, depreciation, electricity, and packaging.

It was assumed that raw material prices remained constant, labor costs did not include additional allowances, and depreciation was evenly distributed over each machine's lifespan, converted to working hours. Electricity costs were calculated based on the equipment's power consumption multiplied by usage hours. It was also assumed that a single type of packaging material was used, and transportation or storage costs were excluded. With this the total cost of Production at trial stands at Nu.375.14/kg of frozen French fries.

Table 5: Proximate cost analysis of the sample products

Particulars	Cost (Nu.)
Raw materials	5760.80
Labour cost	8500.00
Miscellaneous	37.00
Depreciation cost	70.89
Packaging cost	500.00
Electric charges	136.98
Total Cost for 40 (1 Kg packets)	15005.67
<b>Cost per pkt (1 kg)</b>	<b>375.14</b>

## 6.2 Cost of Production (on Trial) versus Cost of Imported frozen French fries

Compared to the cost of imported alternatives, the cost of production (on Trial) is significantly higher with the cost of production standing at Nu.375.14/Kg (Table 5) whereas the selling price of imported frozen French fries is relatively cheaper at Nu.170-194/Kg (Table 1). The difference in costs could be due to the following reasons;

- Since this was a trial the production scale was smaller.
- Raw material and labour costs are higher.
- Process automation and mechanization could however lead to reduced costs.
- The recovery rate of the raw material is comparatively less leading to additional costs incurred per Kg production of frozen French fries.

## 7. Market Comparison

Parameters	Local Frozen fries (Sample Product)	Imported Frozen fries
Costs	Significantly expensive (CoP; Nu. 375.14/Kg)	Cheaper (Nu. 170-194/Kg)
Taste	Comparable except for one report of metallic aftertaste by one restaurant	Comparable
Colour and Texture	Becomes darker more quickly when frying	Not very sensitive in terms of colour change when frying
Oil Usage	Dirties the frying oil faster affecting the oil reusability	Frying oil can be used for multiple times
Storage duration	-Storage questionable -Responders reported poor storage performance in previously available locally processed sample products	-up to one year in a deep freezer -better shelf life after opening the package

\*Note: As per product trial market reception survey (annexure I)

## **8. Conclusion and Recommendations**

Based on the findings from the trial at the NPHC, the feasibility of local production of frozen French fries appears to be limited. The currently available local potato varieties do not meet the minimum technical requirements of dry matter content, which compromises the quality of the final product. Additionally, the low recovery rates recorded further reduce the economic viability of local production by increasing unit costs. The cost of producing locally is also substantially higher factored by expensive raw material and labour costs compared to prices of imported alternatives currently used by restaurants which make being price competitive difficult. Moreover, the production scale was small; scaling up to a larger volume could potentially reduce the overall cost.

To enhance market positioning and achieve competitiveness, we need to explore for a more suitable potato variety specifically adapted to the requirements of French fries production to ensure quality. Only then other interventions to improve recovery rates, scale operations, and mechanization of processes to improve efficiency and ultimately reduce costs be made to have an upper hand against imported alternatives.

## 8. Appendices

### Annexure I: Product Survey Findings (Individual Parameters)

#### 1. Product Quality

##### 1.1. Overall quality of the frozen French fries

On the overall quality of the frozen French fries almost half of the respondents (47.1%) rated the fries as “Good” while 41.2% considered them “Average”. A smaller portion (11.8%), rated the fries as “Excellent” while none of the participants rated the product as “Poor” which shows a positive reception. Overall, the feedback suggests that while the majority of respondents view the product favorably, there is still room for improvement to shift more responses from “Average” to higher satisfaction categories.

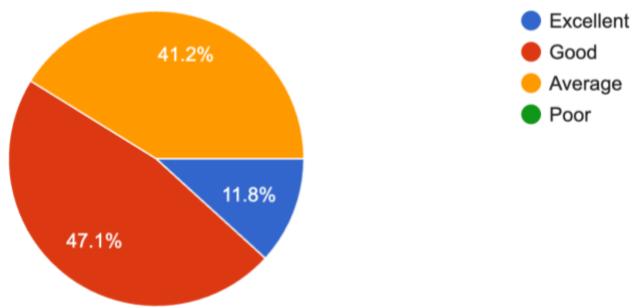


Figure 1: Overall Product Quality of frozen French fries

##### 1.2. Taste satisfaction after preparation

The survey results on taste satisfaction after preparation show that a majority of respondents are satisfied. 58.8% of the responders reported being “satisfied”, while 35.3% remained “neutral”. Only a small portion, 5.9% showed “dissatisfaction”, and none reported that they were “very satisfied”. This feedback indicates a generally positive reception, with most respondents appreciating the taste, though few remained neutral or dissatisfied.

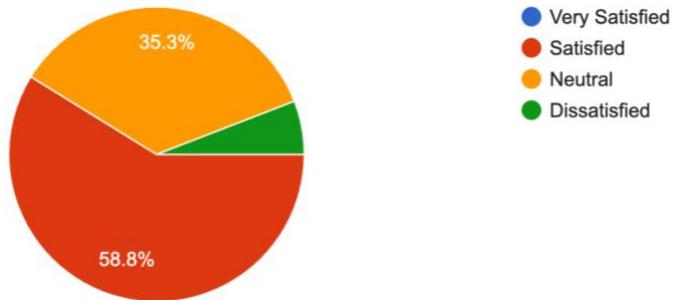


Figure 2: Taste satisfaction after preparation

### 1.3. Crispiness of the product

The feedback on texture and crispiness shows mixed opinions among the respondents. More than half of the participants, 52.9%, rated it as “average” suggesting that the product did not fully meet expectations in terms of crispiness. Meanwhile, 29.4% found it “good”, and only 17.6% rated it as “very good”, indicating that fewer participants were satisfied with the texture. None of the respondents rated the texture as poor, indicating that the overall texture quality is fair but has potential for further improvement.

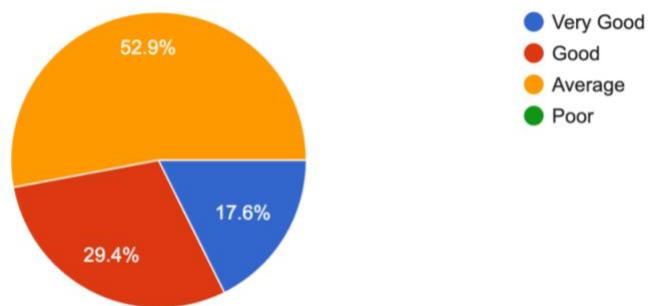


Figure 3: Crispiness/Texture of the product

## 2. Appearance and Consistency

### 2.1. Shape and size consistency

The survey results on the consistency of fries in terms of size and shape indicate positive feedback. 70.6% rated the fries as “consistent”, while 29.4% found them “very consistent”. With none of the respondents rating the fries shape as “inconsistent” indicating that the product meets expectations in terms of shape and consistency.

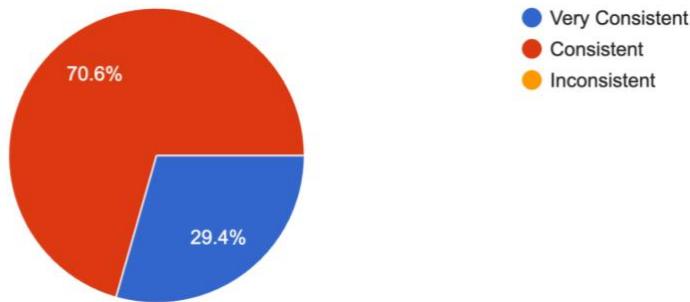


Figure 4: Crispiness/Texture of the product

## 2.2. Colour and appearance after frying

The survey results on the color and appearance of the product after frying indicate that the majority of respondents rated it as “average” (64.7%). About 23.5% of participants found the appearance “appealing”, while a smaller proportion, 5.9%, considered it “very appealing”. On the other hand, 5.9% of respondents rated it as “unappealing”. This suggests that the factors contributing to the visual appearance after frying need to be looked into to ensure its appealness and meet customer expectations.

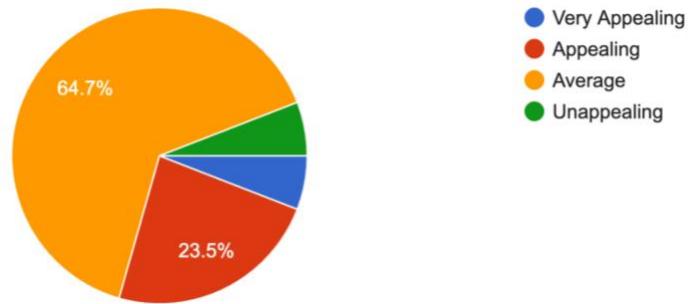


Figure 5: Colour and appearance after frying

## 3. Convenience and Handling

### 3.1. Ease of Handling

The majority of the respondents (75%) found it “easy” to handle the product while 25% found it “very easy” to handle the product.

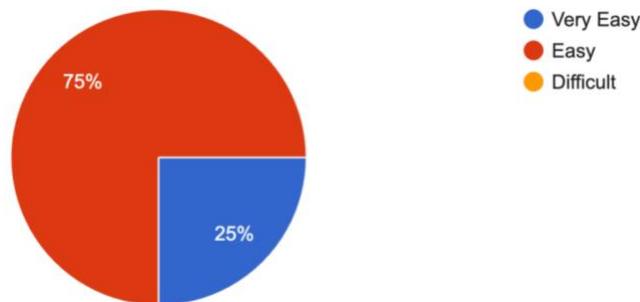


Figure 6: Ease of Handling the product

### 3.2. Ease of Preparation

The responses on satisfaction with cooking time and ease of preparation indicate generally positive feedback. More than half of the participants 52.9% reported being “satisfied”, while 17.6% were “very satisfied”. Meanwhile, 23.5% expressed a “neutral” stance, and a small portion 5.9% rated as “dissatisfied”. This indicates that the majority of respondents found the product convenient and easy to prepare.

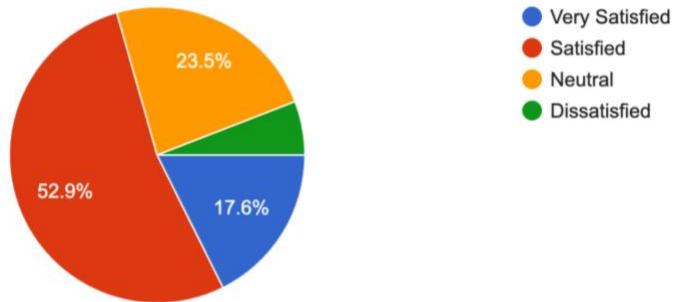


Figure 7: Ease of Preparation

## 4. Comparison with imported alternatives/own preparation

### 4.1. Comparison in terms of imported alternatives/own preparation

The product samples in comparison to the imported alternatives or personal preparation shows that the majority of respondents rated it as “fair” (70.6%). About 23.5% of participants considered it “good”, while only 5.9% rated it as “excellent”. These findings suggest that while the product is generally seen as acceptable, it still falls short to create higher standards in comparison to imported products or home preparation, indicating potential areas for improvement to enhance competitiveness and overall quality perception.

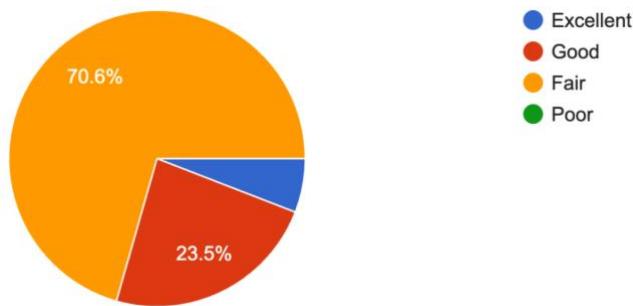


Figure 8: Comparison of the product sample in terms of imported alternatives/own preparation

### 4.2. Consideration/recommendation to replace imported alternatives/own preparation with the product

When asked whether the respondents would consider or recommend replacing imported products or their own preparation with this product, responses are divided. A slight majority of 52.9%

indicated “yes”, showing openness to adopting the product as a substitute. However, 47.1% of respondents said “no” showing significant hesitation to use the sample product. This highlights that while the product has potential acceptance in the market, improvements in quality or appeal may be necessary to convince a larger share of consumers to fully replace the alternatives.

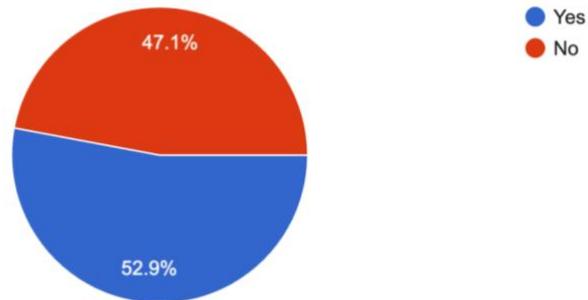


Figure 9: Consideration/recommendation to replace imported alternatives/own preparation with the sample product

## 2. Additional Comments

Additional feedback received on the frozen French fries sample were related to its frying performance, appearance, and overall usability in comparison to the imported alternatives currently being used by restaurants.

Positive comment;

- It was also mentioned that the sample performs better in air fryers with better crispiness compared to imported options, which generally do not turn out as crisp when air fried

Negative comment;

- The product is being reported to darken more quickly during frying which results in a darker final appearance.
- The frying oil also degrades faster, limiting its reusability then which could lead to increased preparation costs.
- One restaurant mentioned that they get a metallic aftertaste, which may be due to the equipment being used while manufacturing and processing the frozen French fries samples.
- Another feedback was on the product’s dimensions which they mentioned that they would prefer for slightly longer fries, ideally up to 9 cm in length.

## 3. Reception of frozen French fries developed from different Varieties

Though the feedbacks received on the different frozen French fries sample products developed from *Yusi-Chip-1* and *Yusi-Maap* varieties were similar, normalized weighted analysis which is a method for combining data by giving different parameters a specific level of importance (weight)

and then scaling the data to a common range (normalization (min:0; max:1) of the feedbacks show that product developed from *Yusi-Chip-1* (2.47) is slightly better than *Yusi-Maap* (2.13) which indicates that it would be more preferable to develop the frozen French fries product using the *Yusi-Chip-1* variety.

*Table 6: Normalized weighted feedback comparison analysis between varieties*

Question	<i>Yusi Chip-1</i>	<i>Yusi Maap</i>
How would you rate the overall quality of the frozen French fries?	0.300	0.244
How satisfied are you with the taste after preparation?	0.275	0.233
How do you find the texture/crispiness?	0.300	0.233
How consistent are the fries in terms of size and shape?	0.396	0.370
How would you rate the color and appearance after frying?	0.250	0.211
How easy is it to store and handle the product?	0.396	0.352
How satisfied are you with the cooking time and ease of preparation?	0.300	0.267
How would you rate the product in comparison to imported alternatives/your own preparation?	0.250	0.222
	<b>Sum</b>	<b>2.467</b>
		<b>2.133</b>

## **Annexure II: Survey Questionnaire**

### **Survey: Quality Assessment of Frozen French fries**

Restaurant Name: \_\_\_\_\_

#### **1. Product Quality**

How would you rate the overall quality of the frozen French fries?

Excellent  Good  Average  Poor

How satisfied are you with the taste after preparation?

Very Satisfied  Satisfied  Neutral  Dissatisfied

How do you find the texture/crispiness?

Very Good  Good  Average  Poor

#### **2. Appearance & Consistency**

How consistent are the fries in terms of size and shape?

Very Consistent  Consistent  Inconsistent

How would you rate the color and appearance after frying?

Very Appealing  Appealing  Average  Unappealing

### **3. Convenience & Handling**

How easy is it to store and handle the product?

Very Easy  Easy  Difficult

How satisfied are you with the cooking time and ease of preparation?

Very Satisfied  Satisfied  Neutral  Dissatisfied

### **4. Comparison with imported alternatives/own preparation.**

How would you rate the product in comparison to imported alternatives/your own preparation?

Excellent  Good  Fair  Poor

Would you consider/recommend replacing the imported product/your own preparation with this product?

Yes  No

### **5. Any Additional Suggestions/Comments**

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### **Annexure III: List of Responders/Restaurant Surveyed**

<b>SN</b>	<b>Restaurant Name</b>
1	Cafe Yellow
2	Mokja
3	Paradise Kitchen
4	The Black Sheep

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5      Uttpal Pizza  
 6      Tough Cookies Espresso  
 7      Desi Bistro Hotel  
 8      Shark Restaurant  
 9      Easy eats 2  
 10     The Seasons  
 11     Mid-Point Restaurant  
 12     Cave Restaurant  
 13     Burger Point  
 14     Khorlo Restaurant  
 15     Silver Woke  
 16     Yak Caffe  
 17     Bhutan Laphing House

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**Annexure III: Chronology of Activities Conducted**

<b>SN</b>	<b>Activity</b>	<b>Date</b>
1	Frozen French Fries Pre-market Survey	August 4
2	Frozen French Fries Development	August 7 – September 18
3	Frozen French Fries Product Sample Reception Trial	September 17 – September 24
4	Frozen French Fries Trial Report Presentation	October 13