

# Incorporation of Pumpkin Powder in the Development of Chocolate

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**Abstract :** Chocolate confectionery occupies a large share of the sweets market, yet it is often perceived as calorie-dense and nutritionally poor. This study aimed to develop a ready-to-eat dark chocolate fortified with pumpkin (*Cucurbita* spp.) powder and pulp, together with peanut flour, wheat flour and jaggery, to improve nutritional value and consumer appeal. A market survey (online and offline) indicated that consumers prioritise cleanliness of food products, followed by price, quality, quantity, variety, packaging and non-seasonal availability, and show a clear tendency towards ready-to-eat foods. Three experimental formulations (T1–T3) were prepared and compared with a control of plain dark chocolate (T0). Sensory evaluation using a 9-point hedonic scale showed that trial T3 (15 g pumpkin powder, 5 g pumpkin pulp, 10 g peanut flour, 10 g wheat flour, 7 g jaggery and 3 g dark chocolate) obtained the highest scores for appearance, colour, flavour, aroma, taste and overall acceptability (8.3), and it was selected for large-scale production. The total production cost was estimated at ₹408.72 per kg, and the product was packed in aluminium foil. The developed pumpkin chocolate offers a nutritious, affordable alternative to conventional chocolate.

*IndexTerms-pumpkin powder; functional chocolate; dark chocolate; jaggery; peanut flour; sensory evaluation; cost economics*

## INTRODUCTION

Chocolate confectionery holds a significant place within the sweets market and is available in a wide range of products. However, confectionery products often carry a poor health image because of their high energy content, which may contribute to obesity and other health problems. There is therefore growing interest in developing confectionery with added nutritional and functional value.

Pumpkin is an excellent source of pro-vitamin A carotenoids and also contains vitamins B and C, carbohydrates, dietary fibre, folic acid, iron, protein, calcium and potassium. Fortifying chocolate with pumpkin powder is an effective way to help overcome nutrient deficiencies, owing to its high vitamin content. The product developed in this work combines pumpkin powder and pulp with peanut flour, wheat flour and jaggery in a dark chocolate base, and is intended to be a good source of fibre and minerals such as iron, magnesium, zinc and copper.

The present work was carried out under the Student READY Experiential Learning Programme (ELP-2) and falls under Module 8 (Grain-based Products: cereals, legumes/pulses and oilseeds) and Module 9 (Chocolate, Confectionery and Snack Products).

## NEED OF THE STUDY.

- To conduct a market survey to understand market demand.
- To calculate the cost economics of the developed product.
- To fill the gap for a pumpkin-based chocolate in the market.

To promote a positive reputation for the chocolate in the market.

### 3.1 Population and Sample

## 3. MATERIALS AND METHODS

### 3.1 Project plan

The project was carried out between 26 May and 16 July 2025 according to the schedule given in Table 1.

**Table 1.** Project schedule

| Date                    | Activity                                                                                                                                                                           |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 26/05/2025              | Distribution of groups and allotment of ELP guides                                                                                                                                 |
| 28/05/2025 – 06/06/2025 | Group discussion and market survey                                                                                                                                                 |
| 06/06/2025 – 28/06/2025 | Trials to standardise the manufacturing process and final product; collection of information on raw materials and products; selection of the optimised trial by sensory evaluation |
| 29/06/2025 – 10/07/2025 | Purchase of raw materials; actual production and marketing; physical and chemical analysis of product and raw materials; daily record keeping and reporting to guide               |
| 11/07/2025 – 16/07/2025 | Preparation of documentation, report and presentation                                                                                                                              |

### 3.2 Market survey

A market survey was used to gather information about existing and potential customers, including pricing trends, customer requirements and competitor analysis. The survey was conducted both online and offline (face to face) among prospective consumers.

### 3.3 Raw materials

Pumpkin powder, pumpkin pulp, peanut flour, wheat flour, jaggery powder and dark chocolate were used. The nutritional composition of the principal dry ingredients is summarised in Table 2.

**Pumpkin powder** is the best source of pro-vitamin A carotenoids and also provides vitamins B and C, carbohydrates, fibre, folic acid, iron, protein, calcium and potassium. **Peanut** (*Arachis hypogaea*) is a legume that is commonly regarded as a nut; it is rich in fatty acids, vitamins, minerals and bioactive compounds, including mono- and polyunsaturated fatty acids, potassium, magnesium, copper, niacin, arginine, fibre,  $\alpha$ -tocopherol, folates, phytosterols and flavonoids, and its consumption improves overall diet quality. **Jaggery** (gur or bellam) is a traditional, unrefined sugar widely used in Indian sweets and baked goods; it imparts a molasses-like taste with caramel notes and can be used as a healthier substitute for refined sugar. **Wheat flour** is a powdered product made from wheat kernels and is mainly used in bakery, confectionery and pasta products (Zareef et al., 2021); it supplies carbohydrates, protein and minerals.

**Table 2.** Nutritional composition of the raw materials (per 100 g)

| Ingredient     | Parameter                    | Value            |
|----------------|------------------------------|------------------|
| Pumpkin powder | Moisture (%)                 | 14.80 $\pm$ 1.20 |
|                | Protein (%)                  | 8.95 $\pm$ 0.05  |
|                | Fat (%)                      | 0.86 $\pm$ 0.03  |
|                | Crude fibre (%)              | 3.25 $\pm$ 0.89  |
|                | $\beta$ -Carotene (mg/100 g) | 32.87 $\pm$ 0.61 |
| Peanut flour   | Carbohydrates (g)            | 16.13            |
|                | Protein (g)                  | 25.80            |
|                | Dietary fibre (g)            | 8.5              |
|                | Total fat (g)                | 49.24            |
|                | Cholesterol (mg)             | 0                |

| Ingredient     | Parameter         | Value         |
|----------------|-------------------|---------------|
|                | Energy (kcal)     | 567           |
| Jaggery powder | Energy (kcal)     | 380           |
|                | Fat (g)           | 0.1           |
|                | Protein (g)       | 0.4           |
|                | Iron (mg)         | 112           |
|                | Potassium (mg)    | 959.1         |
|                | Carbohydrate (g)  | 80            |
| Wheat flour    | Moisture (g)      | 12.67 ± 0.025 |
|                | Protein (g)       | 10.55 ± 0.032 |
|                | Ash (g)           | 0.94 ± 0.010  |
|                | Fat (g)           | 0.94 ± 0.006  |
|                | Carbohydrates (g) | 78.88 ± 0.508 |
|                | Calcium (mg)      | 18 ± 0.506    |

### 3.4 Formulation

Four treatments were prepared. T0 was the control, consisting of dark chocolate only. In T1–T3 the quantities of pumpkin powder, pumpkin pulp, peanut flour, wheat flour and jaggery were varied while the dark chocolate level was held constant (Table 3).

**Table 3.** Composition of ingredients in the experimental trials (g)

| Trial | Pumpkin powder | Pumpkin pulp | Peanut flour | Wheat flour | Jaggery | Dark chocolate |
|-------|----------------|--------------|--------------|-------------|---------|----------------|
| T0    | 0              | 0            | 0            | 0           | 0       | 50             |
| T1    | 5              | 10           | 20           | 10          | 7       | 3              |
| T2    | 10             | 15           | 15           | 10          | 7       | 3              |
| T3    | 15             | 5            | 10           | 10          | 7       | 3              |

### 3.5 Process

The chocolate was prepared according to the following steps:

1. Collection and weighing of the dry ingredients (jaggery powder, pumpkin powder, peanut flour and wheat flour).
2. Weighing and melting of the dark chocolate.
3. Mixing, uniform blending and shaping.
4. Tempering.
5. Moulding.
6. Cooling at 10–15 °C.
7. Packaging of the finished chocolate.

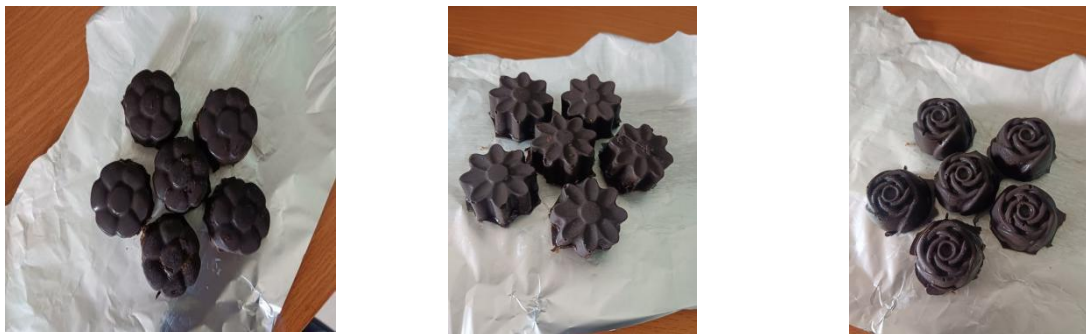


**Figure 1.** Pumpkin chocolate samples prepared in the experimental trials.

### 3.6 Physical analysis

The weight of five randomly selected samples was recorded on an electronic weighing balance. Length, width and thickness were measured using a Vernier calliper.

### 3.7 Chemical analysis

**Moisture.** Moisture content was determined by the FSSAI Manual (Fruit and Vegetable Products, 2016), Method 4.1 (Chovatiya, 2023):

$$\text{Moisture (\%)} = 100 (M_1 - M_2) / (M_1 - M_0)$$

where  $M_0$  = weight (g) of the empty dish,  $M_1$  = weight (g) of the dish with material before drying and  $M_2$  = weight (g) of the dish with the dried material.

**Ash.** Ash content was determined by the FSSAI Manual (Fruit and Vegetable Products), Method 11.3 (Chovatiya, 2023):

$$\text{Ash (\%)} = (W_3 - W_1) / (W_2 - W_1) \times 100$$

where  $W_1$  = weight of the empty dish,  $W_2$  = weight of the dish containing the sample and  $W_3$  = weight of the dish containing the ash.

**Protein.** Protein was determined by the method of IS 7219 (Chovatiya, 2023). Nitrogen was calculated from the difference between the sample titre ( $T_s$ ) and blank titre ( $T_b$ ), using 0.014 g nitrogen per milliequivalent, and converted to protein using the factor 5.7:

$$\text{Protein (\%)} = \text{Nitrogen (\%)} \times 5.7$$

**Fat.** Fat was determined by IS 6287:1985 and expressed by mass on a dry basis (Chovatiya, 2023).

**Dietary fibre.** Total dietary fibre (TDF) was determined by AOAC Official Method 993.21 (Chovatiya, 2023):

$$\text{TDF (\%)} = [W_r - (P + A)] / W_s \times 100$$

where  $W_r$  = mg of residue,  $P$  = protein in the residue,  $A$  = ash in the residue and  $W_s$  = mg of test portion.

**Carbohydrates.** Total carbohydrate was calculated by difference (AOAC, 2012):

$$\text{Carbohydrate (\%)} = 100 - (\% \text{ Moisture} + \% \text{ Ash} + \% \text{ Fat} + \% \text{ Protein})$$

### 3.8 Sensory evaluation

Sensory evaluation analyses and measures human responses to the composition of food. The samples were evaluated for appearance, colour, texture, flavour, aroma, taste and overall acceptability using a hedonic rating scale. The sample with the highest scores was selected for large-scale production.

### 3.9 Cost economics

The production cost was calculated as the sum of raw material cost, processing cost (electricity and fuel), packaging and labelling cost, and labour cost (15% of the raw material cost).

## 4. RESULTS AND DISCUSSION

### 4.1 Market survey

The survey showed that consumers give priority first to the cleanliness of food products, followed by price, quality, quantity, variety, packaging and non-seasonal availability. Consumers were also found to be inclined towards ready-to-eat products. In view of these findings, pumpkin chocolate was developed as a ready-to-eat, nutritionally improved confectionery product.

### 4.2 Innovativeness

The product is based on substituting pumpkin pulp and pumpkin powder in specified ratios. To suit consumer preferences, a low-calorie chocolate with pumpkin as a main ingredient was developed, which is rich in vitamins and minerals and has a low glycaemic index (Athawale et al., 2015). Chocolates sold in stores are typically made with dry fruits or refined wheat flour, or both; here, part of the refined wheat flour is replaced by pumpkin and peanut, which increases the nutritional value.

### 4.3 Sensory evaluation

The mean hedonic scores of the four treatments are presented in Table 4. T3 received the highest scores for appearance (8.5), colour (9.0), texture (8.2 — second to T2 at 8.4), flavour (8.7), aroma (8.3), taste (8.7) and overall acceptability (8.3). Increasing the pumpkin powder level to 15 g, with correspondingly lower peanut flour and pulp, therefore gave the most acceptable product. T3 was selected for large-scale production.

**Table 4.** Mean sensory scores of pumpkin chocolate (hedonic scale)

| Trial | Appearance | Colour | Texture | Flavour | Aroma | Taste | Overall acceptability |
|-------|------------|--------|---------|---------|-------|-------|-----------------------|
| T0    | 7.7        | 7.6    | 7.7     | 8.3     | 7.5   | 7.6   | 7.7                   |
| T1    | 7.8        | 8.0    | 7.8     | 7.7     | 7.7   | 7.5   | 7.4                   |
| T2    | 8.0        | 8.3    | 8.4     | 7.9     | 7.9   | 7.8   | 7.6                   |
| T3    | 8.5        | 9.0    | 8.2     | 8.7     | 8.3   | 8.7   | 8.3                   |

### 4.4 Cost economics

The cost was worked out for a 1 kg batch of the selected formulation (T3), using the ingredient proportions per 100 g of product (Table 5) and the market price of each ingredient. Raw material cost for each ingredient = quantity used (g) × price per 100 g ÷ 100.

**Table 5.** Raw material cost for 1 kg of pumpkin chocolate

| Raw material   | Quantity per 100 g product (g) | Quantity per 1 kg product (g) | Market price per 100 g (₹) | Cost for 1 kg product (₹) |
|----------------|--------------------------------|-------------------------------|----------------------------|---------------------------|
| Pumpkin powder | 30                             | 300                           | 40                         | 120.00                    |
| Peanut flour   | 20                             | 200                           | 69                         | 138.00                    |
| Wheat flour    | 20                             | 200                           | 4                          | 8.00                      |
| Jaggery powder | 14                             | 140                           | 12                         | 16.80                     |
| Pumpkin pulp   | 10                             | 100                           | 4                          | 4.00                      |
| Dark chocolate | 6                              | 60                            | 47.5                       | 28.50                     |
| <b>Total</b>   | <b>100</b>                     | <b>1000</b>                   |                            | <b>315.30</b>             |

**Table 6.** Processing (electricity and fuel) cost for 1 kg batch

| Equipment        | Power rating (kW) | Working time (min) | Energy consumed (kWh) | Cost (₹)    |
|------------------|-------------------|--------------------|-----------------------|-------------|
| Grinder          | 0.5               | 5                  | 0.042                 | 0.08        |
| Weighing balance | 0.1               | 10                 | 0.017                 | 0.03        |
| Gas (fuel)       | 90 g/h            | 60                 | 90 g                  | 6.00        |
| <b>Total</b>     |                   |                    |                       | <b>6.12</b> |

Electricity cost was calculated at ₹2 per kWh (energy consumed = power rating × working time ÷ 60). Labour cost was taken as 15% of the raw material cost ( $0.15 \times 315.30 = ₹47.30$ ), and packaging and labelling was taken as ₹40 per kg. The total production cost per kg is therefore:

$$\begin{aligned} \text{Total cost} &= \text{raw material} + \text{processing} + \text{packaging and labelling} + \text{labour} \\ &= 315.30 + 6.12 + 40.00 + 47.30 = \mathbf{₹408.72 \text{ per kg}} \end{aligned}$$

For the 4 g piece described on the label, this corresponds to a production cost of about ₹1.63 per piece ( $408.72 \times 4 \div 1000$ ), against a printed MRP of ₹10.

#### 4.5 SWOT analysis

**Table 7.** SWOT analysis of pumpkin chocolate

|                                                                                                                                                                                                                                                                                                               |                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Strengths</b></p> <ul style="list-style-type: none"> <li>• Can be consumed by all age groups</li> <li>• Ready-to-eat food product</li> <li>• Attractive shape, colour and texture</li> <li>• Easy availability of raw materials and ingredients</li> <li>• Reasonable price of raw materials</li> </ul> | <p><b>Weaknesses</b></p> <ul style="list-style-type: none"> <li>• Weak distribution network</li> <li>• Lack of marketing skills</li> </ul> |
| <p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>• Wide range of consumers</li> <li>• Low price of product</li> </ul>                                                                                                                                                                       | <p><b>Threats</b></p> <ul style="list-style-type: none"> <li>• New competitors in the market</li> </ul>                                    |

#### 4.6 Packaging and labelling

Packaging is the technology of enclosing or protecting food products to aid distribution, marketing and storage. Aluminium foil was used to package the pumpkin chocolate. It protects the chocolate from temperature changes and helps maintain its shape and consistency. Being highly malleable, the foil conforms closely to the product and gives a tight, secure pack, which is particularly useful for moulded and irregularly shaped chocolates.



**Figure 2.** Aluminium foil packaging used for the chocolate (representative image).

The label lists the ingredients (pumpkin powder, peanut flour, wheat flour, jaggery, dark chocolate and pumpkin pulp) and the approximate nutritional facts per 100 g (protein, fat, carbohydrates, crude fibre, minerals and calcium). It also carries the MRP (₹10, inclusive of all taxes), packed number, batch number, net weight (4 g) and a best-before period of one week from the date of packing.

## 5. CONCLUSION

Chocolates found in stores are typically made with dry fruits or refined wheat flour alone, or both together. In this study, the nutritional value of chocolate was improved by substituting pumpkin powder, pumpkin pulp, peanut flour and wheat flour for part of the formulation, with pumpkin partly replacing refined wheat flour. In sensory evaluation, trial T3 received the highest ratings and is therefore a good choice for large-scale production. With an estimated production cost of ₹408.72 per kg and a market that favours ready-to-eat products, pumpkin chocolate has good potential as an affordable, nutritious confectionery.

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