

International Journal of Agriculture Extension and Social Development

Volume 8; Issue 12; December 2025; Page No. 645-648

Received: 04-09-2025
Accepted: 07-10-2025

Indexed Journal
Peer Reviewed Journal

Development and Study of Kodo Millet Chocolate

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DOI: <https://www.doi.org/10.33545/26180723.2025.v8.i12i.2819>

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Abstract

Kodo millet (*Paspalum Scrobiculatum*) is an underutilized cereal crop that can thrive in tough climates, making it a great choice for sustainable farming in dry areas. This crop tolerates drought well and can grow in difficult soils, such as shallow, stony, and acidic fields, where most major cereals fail to perform well. Kodo has minimal requirement for fertilizers, water, labor, and pest control makes it ideal for small-scale farmers with limited resources with maturity time of 80 to 100 days, Kodo millet is suitable for crop rotation and double-cropping plans. The plant naturally resists common pests and diseases, which cuts down the need for pesticides and supports organic farming. Its deep roots help protect the soil, especially in sloped and erosion-prone regions, while intercropping and rotating with pulses can boost soil health and crop yield. Furthermore, the crop's ability to handle heat stress, changes in moisture, and climate variability further supports its growth in a changing environment. Incorporation of roasted Kodo millet powder with dark chocolate results in a value-added product which can be used to attract consumers of various age groups as dark chocolate is known widely for its cardiovascular, anti-inflammatory and antioxidant properties.

Keywords: Kodo millet, food product development, chocolate formulation, nutritional evaluation, value addition

Introduction

Kodo Millet (*Paspalum Scrobiculatum* L.) a millet species Belonging to 'Poaceae' Is traditionally grown in semi arid region of Madhya Pradesh, Chhattisgarh, Maharashtra, Tamil Nadu and Karnataka. It has made its name due to its climate resilience ability and suitability for sustainable agriculture. It is also an extremely underrated crop as it can thrive in poor soil, requires low rainfall and minimal input requirements where major cereals fail. Additionally resistance to pest make it a cost effective crop for small and marginal farmers.

Nutritional Composition of Kodo-

The Millet is phenomenal Because of richness in calcium dietary fibre and polyphenol. Due to richness in magnesium it helps to counter migraine and heart attack to some extent, While the phosphorus presents Is a crucial component for formation of adenosine triphosphate (ATP) to build energy in body. It is also called 'nutria-cereal' Because being rich in vitamins, minerals, phytochemicals and essential amino acids like lysine, theonine and valine. Kotomilites also contain rich amount of vitamin B-3, Vitamin B-6, folic acid as well as zinc. The grain of Kodo millet contains high amount of crude fibre (9%) When compared to wheat (1.2%). Per 100 gm of grain provides 353 Kcal of energy. Kodo millet contains 8.3% of protein, 66.6% of carbohydrate, 2.4% minerals, 2% ash and 1.4 percent fat.

Introduction to chocolate

Chocolate which is originated from word cacao is a value Added product obtained when the seeds are dried and

roasted after obtaining from cacao tree (*Theobroma Cacao*). The rich flavour smooth Texture and great versatility in cooking have made it an important item in food and industrial market. Nutritionally chocolate has carbohydrates, fat, mineral and compounds such as flavonoids like catechins and procyanidins. All these contribute to its antioxidant properties which brings heart and brain health benefits. Factors such as roasting methods, fermentation conditions, cocoa variety completely decides the composition and quality of chocolate.

Scope of Study

This study aims for development of value added chocolates while taking in use of cheap and underutilised crop (Kodo Millet). Chocolates made by mixing roasted Kodo millet flour and dark chocolates in different proportions (15:85; 20:80; 25:75; 30:70 and 100% dark chocolate as control). Production and consumption of Kodo Millet chocolate provides a healthier alternate to consumers for traditional snack while ensuring nutrient availability and its utilisation.

Objectives of Study

1. Development of chocolate to determine nutritional value of product.
2. To evaluate physico-chemical properties and sensory analysis of final product.

Material and Methods

All the materials are listed below along with the raw materials which are used for making the product. The tests are performed in Food and Nutrition Laboratory of Bhartiya

College of Agricultural Engineering, Durg, Chhattisgarh.

Kodo Millet

The Kodo Millet used for preparation of Kodo Millet Chocolate is brought from local market, Durg.

Dark Chocolate

Dark chocolate compound is obtained from the market of Durg.

Chocolate casting mold

Mold used for shaping the chocolates is brought from local market, Durg

Weighing balance

The weighing scale with accuracy of 0.001 gm to 0.1 gm is used for weighing the materials.

Blender

For grinding the Kodo Millet to fine powder.

Induction cooktop

Induction cooktop is used to melt the dark chocolate in order to blend it with kodo millet flour effortlessly.

Refrigerator

Refrigerator is used to cool the chocolate at required temperature.

Air tight containers

Air tight containers were used for preserving the freshness and quality of chocolate by creating a sealed environment which prevents introduction of air, moisture and contaminants.

Other minor equipments

- Bowl
- Spatula
- Steel pan
- Sieve

Preparation of Kodo Millet Chocolate

Initially the Kodo millet is grinded into fine powder using blender. Then by using sieve the fine particles of powder is separated from coarser particles. Then on a heated steel pan the powdered kodo is roasted. By using double boiler method the chocolate is heated till it gets melted completely. Thereafter in a bowl the melted chocolate and roasted kodo millet powder is mixed thoroughly so that required consistency is achieved and no lumps are left behind.

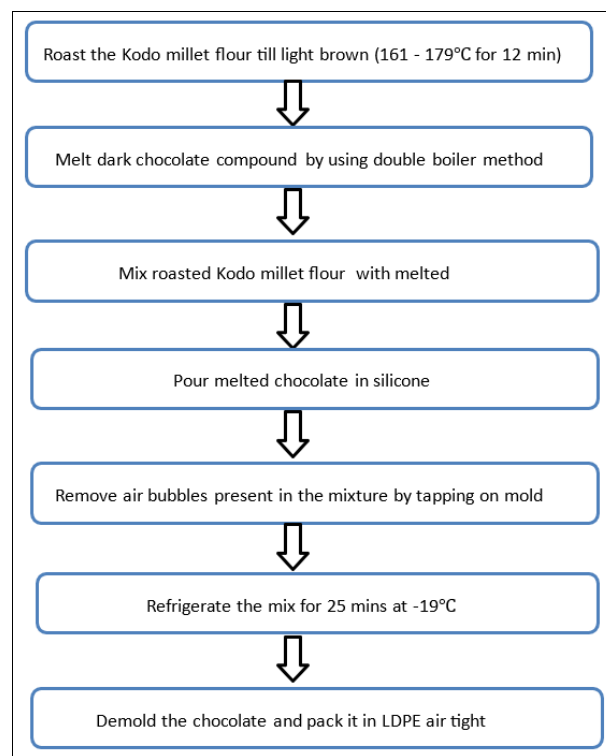
Different variations of chocolates were made by using different concentration of materials i.e. in S1 for every 10 gm of product 8.5 gm of chocolate and 1.5 gm of Kodo powder is used. In S2, 8 gm of chocolate and 2 gm of Kodo powder is used. In S3, 7.5 gm of chocolate and 2.5 gm of Kodo powder is used. In S4, 7 gm of chocolate and 3 gm of Kodo powder is used. Also a control sample is made only using dark chocolate to compare with our samples.

After mixing and achieving desired consistency the mixture is poured into chocolate casting mold. It is must to give gentle tap to the chocolate mold so that no air bubbles are left and proper consolidation of mixture which brings proper

shape of chocolates. The mold is then kept in freezer for about 20 minutes at -19° Celsius which hardens the chocolate. Subsequently the chocolate will be carefully demoulded, wrapped in aluminium foil and packed in LDPE (Low-Density Polyethylene) boxes. The chocolates will be grounded into fine powder to undergo further processing including analysis of nutritional composition such as moisture, ash, protein and sugar content.

Table 1: Kodo chocolate with different concentration

S. No.	Treatment	Chocolate	Kodo
1	S1	85	15
2	S2	80	20
3	S3	75	25
4	S4	70	30
5	S5	100	0



Flow Chart 1: Preparation of Kodo Millet Chocolate

Physiochemical analysis of Kodo Millet Chocolate

Determination of moisture content

Moisture content was measured using “AOAC Method”. A Sample of 5g product was weighed in an aluminium dish and allowed to dry in a hot air oven maintained at 100°C for 4 hours. It was cooled in desiccators to room temperature, until constant weight is achieved. Difference in weight in percentage was reported as moisture content.

$$\text{Moisture (\%)} = \frac{\text{Initial sample weight} - \text{Final sample weight}}{\text{Initial sample weight}} \times 100$$

Determination of ash content

Ash content was determined by using a Muffle furnace. A sample of 5g of product was weighed in silica crucible and place in muffle furnace. It was kept in muffle furnace maintained at 550°C for 4 hours. It was cooled in desiccator and then weighed. This was repeated until two consecutive

weights were constant. The percentage ash was calculated using the difference between initial and final weight.

$$\text{Ash (\%)} = \frac{\text{Ashed weight} - \text{Crucible weight}}{[\text{crucible and sample weight}] - \text{crucible weight}} \times 100$$

Determination of protein content

Protein content was determined using micro Kjeldahl method, where 0.5g of sample was take and digested with concentrated sulphuric acid (H₂SO₄) containing pinch of catalyst mixture (K₂SO₄: HgO: CuSO₄, 99:4.1:0.8). Then digested solution was distilled with 40% NaOH and liberated ammonia was trapped in 4% boric acid, using mixed indicator (methyl red: bromocresol green, 1:5). The percentage nitrogen was calculated by using following formula and protein percentage was quantified in the sample by multiplying with a factor of 6.25.

$$N (\%) = \frac{\text{Titre(ml)} \times N \text{ of HCL} \times 0.014 \times 25 \times 100}{\text{Aliquot taken} \times \text{Weight of sample}}$$

Determination of carbohydrate content

The total sugar content was estimated by Phenol – H₂SO₄ method using glucose as standard as described by Wankhede and Tharanathan (1976). The sample (0.5g) was weighed accurately in test tube and kept in ice water bath for few minutes followed by addition in test tube and kept in ice water bath for few minutes followed by addition of cold H₂SO₄ (72%) with gentle stirring. It was refluxed at 98 °C for 3-4 hours to achieve complete hydrolysis. The orange yellow colour was read at 480 nm on spectrophotometer (Thermo Electron Corporation, Model: Spectronic 20D+) from the calibrated curve the concentration of sugar in hydrolytic solution was calculated and percent total sugar in the sample was quantified.

Chemical analysis

There were 4 tests namely protein, carbohydrate, ash content and moisture content which were determined as follows for kodo millet chocolate.

Table 2: Chemical parameters of Kodo Millet Chocolate

S. No.	Sample	Ratio (Chocolate: Kodo)	Moisture Content (%)	Ash Content (%)	Protein Content	Carbohydrate Content
1	S1	(85:15)	98.55	0.029	5.33	20.44
2	S2	(80:20)	98.98	0.026	5.51	19.88
3	S3	(75:25)	99.33	0.015	5.68	18.08
4	S4	(70:30)	99.45	0.032	5.86	17.07
5	S5	(100:0)	99.43	0.016	4.8	24

Sensory Evaluation

Sensory evaluation was performed on prepared Kodo millet chocolate. A 9 point hedonic scale is used where a panel of members were asked to give rating on basis of taste, flavour,

mouthfeel, bitterness and hardness which are mentioned in the table given below and overall acceptability is calculated on the data presented.

Table 3: Sensory parameters of Kodo millet chocolate

Samples	Taste	Flavour	Mouthfeel	Bitterness	Hardness	Overall Acceptability
S1	8.2	8.2	7.6	8.4	8.2	8.2
S2	8.2	8.3	7.5	8.3	8.3	8.2
S3	8.4	8.6	7.4	8.2	8.5	8.3
S4	8.1	8.6	7.3	7.8	8.6	8.1
S5(Control)	8.8	8.1	8.6	8.9	7.6	8.4

Conclusion

Although Kodo millet offers significant nutritional and agronomic advantages with consumption in urban areas remain comparatively low. By introducing it with chocolate we can significantly improve its utilisation. With potential for commercialization it can contribute to economic development as well. From the study we have obtained codominant chocolate with various concentration of Kodo and chocolate which were S1(1.5gm&8.5gm), S2(2 gm&8 gm), S3(2.5 gm &7.5gm) and S4(3 gm&7g m). From the sensory evaluation the sample S3 was found to be most pleasing and acceptable as compared to other samples.

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