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Preparation, Evaluation and Economics of Traditional Indigenous Foxtailmillet Value-Added Product–Haalbai

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Abstract: **Problem:** Requirement of nutritious and traditional food products along with the value addition of millets to encourage its consumption among community. **Approach:** Efforts have been made to develop value added traditional food product – Haalbai, from foxtail millet to enhance the nutritive value. **Findings:** Millets, including foxtail millet, are essential parts of the Indian diet. Chronological evidences illustrate the evolution of millet consumption since the Indus Valley Civilization to the Colonial era and to the present day in the religious, social, and ethnic practices of India. They have played a significant role in celebrations, customs, and traditional diets—in rural tribal and urban societies. Food processing is an important operation, as it improves the bioavailability of nutrients and sensory properties and decreases antinutrients. Traditional foods have the potential to maintain health, nutrition, well-being in a simple, cost-effective way. It is imperative to explore value-added products with the increasing world population to feed its growing population by using; consuming locally food sources in low income households in developing nations. To this end Foxtail millet is a rich source of various macro and micronutrients and well established health and well-being potential. The present study was aimed at preparation and evaluation of haalbai a value-added confectionary from foxtailmillet. The nutritive value results indicate higher in Moisture (60.59), Fat (0.36), protein (2.37), Energy (157 K.Cal/100g) and minerals such as Calcium Ca (28 mg/100g), Iron Fe(2 mg/100g). The microbial and Mold count were lower and aluminium was suited as the best packing material. The nine points hedonic scale of sensory attributes viz., appearance, colour, texture, taste and flavor, and overall acceptability rate was in the range of previous reports. **Conclusion:** Cumulatively we have developed a simple; cost effective value added product of Foxtail millet.The product has several health and nutritional advantages hence suitable in promoting food supplementation.

Keywords – Traditional Food, Haalbai, Sensory Evaluation, Hedonic Scale and Foxtail Millet

1. Introduction

Millets, with their entrenched historical importance, cultural significance, and exceptional health benefits hold a unique place in shaping India's agricultural practices, food systems, and cultural ethos(Jain et al., 2024).This is attributed to the resilience, nutritional richness, and deep cultural ties of the millet(Kumari 2023). Cultivation of millets can be traced from through archaeological evidence, historical texts, and cultural practices. The evolution of millet farming in response to shifting socio-political situations spans from the Indus Valley Civilization to the Mughal and Colonial eras to the present religious, social, and ethnic practices(Gochhayat and Chhabra 2025). The popularity of millet cultivation and eating across India is attested to both historical writings like the Yajurveda and mentions in mediaeval narratives like AbulFazl'sAin-i-Akbari(Spengler 2019). Millets, including finger millet (ragi), pearl millet (bajra), sorghum (jowar), and foxtail millet, are essential parts of the Indian diet(Jacob et al., 2024).These grains have always played a significant role in celebrations, customs, and traditional diets—particularly in rural and tribal societies.

The traditional knowledge and biodiversity connected to millets have been conserved via ethnic rituals in India. Historical evidences and traditional cultural practices shed light on the millet-based meals utilized in ceremonies and festivities in several parts of Rajasthan, Karnataka, and Nagaland (Newmaster et al., 2013). Millet-based meals are a common element of tribal festivities and festivals like Makar Sankranti. Millets are deeply ingrained in our cultural history and have historically been important in tribal regions temple celebrations. Millets are served in various functions such as wedding ceremonies, crop harvesting celebrations, rituals, and death ceremonies(Siripurapu, et al., 2019).Diversity of millet as a functional food source is intermixed with local culture and traditions in India(Warisa et al., 2024). In Karnataka, millet is also mentioned in oral traditions and folklore, where it frequently represents fertility, prosperity, and the connection between the society and agriculture the poem "Ragithandheera" composed by the Indian poet Purandara Dasa in the fifteenth century and "Ramadhanya Charithe", by Kanakadasa, from the sixteenth century have immortalized finger millet(Pramitha et al., 2023). Women have been singing songs while performing various tasks related to agricultural work and food preparation for more than a thousand years. These have demonstrated the historical popularity of finger millet Newmaster et al., 2013. Indians have been using millets into a myriad of ethnic dishes for a very long time and were an integral part of traditional diets for centuries(Choudhary et al., 2024). In Southern India, finger millet has been malted for use in food during throughout history(Kumar 2024). Ragihurihittu, a meal prepared with popped finger millet, is rich in minerals and vitamins. Mudde, is prepared fromarka (kodo millet), saame (little millet), and navane (foxtail millet) millets. These dishes are served with sambhar (vegetable stew), made from a variety of local beans with rich scent and nutritional value. Ambali is a traditional South Indian semi-liquid food made from fermented millet(Sarkar, et al., 2015). List of some millet based ethnic Indian foods is listed in Table 1.Severalethnical, traditional and ethnomedicinal properties are associated with the millets(Chauhan 2023). The Bastar plateau zone tribes use Kodo millet for treatment of Tympany disorder a fatal disease of cattle. The entire panicle of Foxtail millet is used as feed for birds and fodder for

livestock by Paniya tribe of Wayanad, Kerala. Kurumas tribe of Wayanad, Kerala, use Proso millet seeds (*Panicumrepens*) as poultry feed and Foxtail millet to treat dyspepsia, poor digestion, and bone fracture. Bhotiya of Niti Valley, Uttarakhand, consumes Proso millet in case of measles and barnyard millet to cure Jaundice.Ziro Valley, Arunachal Pradesh, tribes use grains of finger millet for the cure of stomach disorders and colds.

Foxtail millet is a rich source of various nutrients, including B vitamins, calcium, iron, potassium, magnesium, and zinc.Also it is gluten-free with a low glycemic index, making it suitable for people with allergies/intolerance, diabetic and obesity(Jacob et al., 2024). Health-promoting benefits of millets include diseases such as diabetes, cataract development, and cardiovascular disorders(Sahoo, et al., 2025). Also foxtail millet has therapeutic potential of dietary millet fiber interventions in illnesses like anxiety, depression, and neurodegenerative disorders(Zhu et al., 2018). These health-benefits have been investigated in several preclinical and clinical investigations.Food processing is an important operation, as it improves the bioavailability of nutrients and sensory properties and decreases anti - nutrients(Haji, et al., 2024). Primary processing includes cleaning, washing (soaking/germination), dehulling, milling (to make flour and semolina), and refining to get rid of antinutritional elements and the undesirable seed coat.Secondary processing is the process of flaking, popping, extrusion, and baking to transform primary processed raw materials into ‘‘ready-to-cook’’ (RTC) or ‘‘ready-to-eat’’ (RTE) products(Gowda et al., 2022).Value-added products made from foxtail millet are low in calories, gluten-free, high in phenolic compounds, slow down digestion by causing satiety, and lower oxidative stress (Goudar et al., 2023).

Various millet-based products are available in Indian market such as pasta, noodles, breakfast cereals, and snacks and range of beverages. Further, processing methods improve physico-chemical, nutritional, bioavailability and sensory properties. Several methods in the processed food preparations are used by researchers(Yousaf et al., 2021). The physico-chemical characteristics determine the stability of different value-added products and prepared ready-to-eat foods (Munshi et al., 2024). Ayin et al., 2021 reports raw finger millets, foxtail millets and chameleon herbs powder found to be rich in Fe, ca, fiber, protein and phosphorus and it can be successfully incorporated in the preparation of the value added food products like Cookies, Dhokla and Idli. These constituents help to boost immunity, control infectious seasonal diseases. Several value-added, ready to eat products prepared from foxtailmillet are currently developed and in use. These include sweets Laddu (Sudhaet.al., 2022), bakery products such as Rusk and Cookies (Sadhu and Naidu 2021) and savouries such as Kheer(Arora et al., 2023) noodles (Yue et al., 2025) and vermicelli(Pandey 2017). The production and development of these products are based on the regional variety of millet, physico-chemical properties and food habits and preferences of the region. Foxtail millet kheer and foxtail millet bisibele bath are unique delicacies of Karnataka.

With the increasing need to feed the world and its growing population, it is imperative to explore food crops such as foxtail millets that are grown locally and can be consumed by low income households in developing nations (Kheya2023). Further, traditional foods have potential to maintain health, nutrition, well-being which is simple, cost-

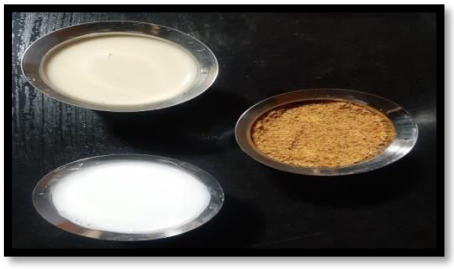
effective and easy to prepare options. In summary, with this literature background in the present study we aimed to develop value-added products Halabai from foxtail millet prepared and assessed its microbial and sensory properties at department of Food Technology, Davangere University, Davangere, Karnataka.

2.Materials and methods

Flow chart-1represents the various steps in the preparation of Foxtail Millet Haalbai.Plate 1, and 2 depict the ingredients for foxtail millet Haalbai and a final prepared Haalbai product. The ingredients used and proportions are tabulated in Table-1

Foxtail millet grains
↓
Cleaning
↓
Washing
↓
Soaking (24 hrs)
↓
Grinding (5 minutes) with water 1:2 ratio
↓
Milk extraction
↓
Coconut milk extraction in 1:1 ratio
↓
Mixing with ingredients
↓
Boiling (120^{0}C for 15 min)
↓
Moulding
↓
Demoulding
↓
Labelling
↓
Storage

(Flow chart for the preparation of Haalbai)



(Plate 1: Ingredients for foxtail millet Haalbai)

(Plate 2: Final prepared Haalbai)

Table 1: Treatment details of foxtail millet (ingredients)

Treatments	**T0**	**T1**	**T2**	**T3**	**T4**
Foxtail Millet Milk (ml)	00	25	**50**	75	100
Coconut milk (ml)	100	75	**50**	25	00
Jaggery (g)	40	40	**40**	40	40
Cardamom (No.s)	1	1	**1**	1	1

The Moisture content was determined by A.A.C.C. 2000 method.The biomolecules contents:Fat Protein and Carbohydrate were determined by A.O.A.C 2000 method. Further, the Ash content was determined by A.O.A.C 2000 method.Calcium and Iron content were determined by A.O.A.C 2000 method.Energy content was determined through calculation method (Raguramulu et.al., 1983). Standard plate count of foxtail millet was taken as per the method of Harrigan and Maccance (1996). The organoleptic (sensory) evaluation of the products such as colour and appearance, texture, flavour, taste and overall acceptability was carried out using 9 points hedonic scale (Srilaxmi, 2010). Statistical analysis was done in EXCEL.

Storage Studies

Haalbai was stored in Aluminum pouches and LDPE pouches of food grade standard along with the control Rice Haalbai in refrigeration temperature (4°C). The pouches were removed at the interval of two days to analyze the sensory parameter. When the sensory evaluation score was 5 or less i.e. neither like nor dislike, the product were been taken to chemical and microbial analysis to know the cause of spoilage.

3.Results

a. Determination of Nutritive Composition

Table 2: Sensory evaluation of Trials of Foxtail millet confectionary –Haalbai

Parameter	**Color and Appearance**	**Texture**	**Flavor**	**Taste**	**Overall Acceptability**
T0	8	7	7	7	7
T1	8	7	6	8	7
T2	**8**	**8**	**8**	**9**	**8**
T3	8	8	7	7	7
T4	8	7	7	8	7

So T2 is taken further for all the analysis.

The Nutritive data is summarized in Tables-3 and 4 .The value of Moisture (60.59%), Fat (0.36%), protein (2.37%) and Ash (0.67%) were higher in comparison to other studies. The mineral Components of foxtail millet grains were as follows (mg/100g)-Calcium Ca(28) and Iron (2).

Table 3: The Nutritinal composition of foxtail millet and rice Halabai

Sl No.	**Parameter**	**Foxtail Millet Haalbai (Quantity)**	**Rice Haalbai (Quantity)**
1	Moisture (g)	60.59	70.50
2	Ash (g)	0.67	1.38
3	Protein (g)	2.37	1.57
4	Fat (g)	0.36	0.07
5	Carbohydrates (g)	36.01	26.78
6	Energy (K.cal)	157	114

Table 4: Mineral composition of foxtail millet and rice Halabai

Sl No.	**Parameter**	**Foxtail Millet Haalbai (Quantity)**	**Rice Haalbai (Quantity)**
1	Calcium (mg/100g)	28	46
2	Iron (mg/100g)	02	01

Microbial analysis

Total Plate Count and Yeast &Mold Count during storage are represented in Table-5a andb. Microbial analysis becomes an important issue from the safety point of view of all food processing and product formulations. The developed products recorded increasing trend in total bacterial count (7500; 5300)and Yeast and Mold counts(10; 9)on 8th day. Foxtail halabai had lowered microbial and Mold counts in comparison to the rice halabai.

As evident the values combination of Rice and Foxtail Millet packed in aluminum foil has significant impact on microbial growth. Further, the Yeast and Mold Count was also reduced in both products packed in aluminum foil. The data is within the data range reported by other researchers in other millet food products.

Table-5: Microbial assays of Halabai

Parameter (cfu/ml)	**Storage period (days)- TPC**		**Storage period (days) – Yeast and Mold Count**	
	0	**8**	**0**	**8**
T_1P_1	0	7500	0	10

T_1P_2	0	7100	0	10
T_2P_1	0	5700	0	9
T_2P_2	0	5300	0	9

T_1 = 100% Rice, T_2= 100%, Foxtail Millet
P_1= LDPE, P_2= aluminium foil

Storage Studies

Storage quality of any developed food product is a crucial factor to be considered for use and commercialization. For further shelf life enhancement, it is essential to adopt a packaging technique that preserves the flavour and taste of food also protects the food from spoilage and does not leave any undesired aftertastes. Further, the material should not pose health hazards during heated

From the data of this study (Tables) it could be inferred aluminium packing had no effect on the organoleptic properties of Halabai. Aluminium is a long-term food packing material combining durability and lightness. At the same time it has a high degree of robustness which prevents corrosion and spoilage and recyclable (Deshwal et al., 2020).

F. Sensory evaluations

The organoleptic quality parameters of a product assume pivotal role in anticipating the consumer preference to the product.A nine point hedonic scale was used, which describes sensory attributes viz., appearance, color, texture, taste and flavor on nine point hedonic scale. Sensory evaluation was done by a panel of 10 semi trained judges of Department of Food technology, Davangere University,Davangere, Karnataka.The data is tabulated in tables 6(a-f).The scores for change in color value, flavorwas in the range of previous data of foxtail products(Hiregoudar and Mamatha 2022; Thara and Nazni 2021; Sudha 2021). The rice halabai had better colorvalues in comparison to Foxtail halabai (7.25±0.26;7.15±0.24) in LDPE and aluminum packages respectively. The Foxtail halabaihad better flavorvalues in comparison to rice halabai (4.40±0.45). Also the Foxtail halabai had better texture and taste values (7.70±0.32; 4.65±0.47) in comparison to rice halabai. Finally, the overall acceptable was acceptable for both the products.

Table 6a. Changes in Colour value of Foxtail Haalbaiduring storage

Parameter	**Storage period (days)**				
	0	**2**	**4**	**6**	**8**
T_1P_1	8.60±0.46	8.25±0.26	7.95±0.28	7.80±0.26	7.25±0.26
T_1P_2	8.40±0.37	8.15±0.28	7.90±0.21	7.75±0.26	7.15±0.24
T_2P_1	8.60±0.46	7.95±0.28	7.80±0.26	7.70±0.25	7.00±0.00
T_2P_2	8.40±0.37	7.95±0.16	7.75±0.26	7.65±0.24	7.00±0.33

* Maximum score out of 9. Results are mean value of 10 replications.
T_1 = 100% Rice, T_2= 100%, Foxtail Millet
P_1= LDPE, P_2= aluminium foil.

Table 6b. Changes in Flavor value of Rice Haalbaiduring storage

Parameter	**Storage period (days)**				
	0	**2**	**4**	**6**	**8**
T_1P_1	8.70±0.48	8.30±0.48	7.50±0.41	6.70±0.58	4.30±0.48
T_1P_2	8.70±0.48	8.20±0.42	7.55±0.49	6.50±0.47	4.20±0.42
T_2P_1	8.60±0.51	8.10±0.31	7.45±0.43	6.40±0.31	4.50±0.94
T_2P_2	8.60±0.51	8.15±0.33	7.45±0.43	6.50±0.40	4.40±0.45

* Maximum score out of 9. Results are mean value of 10 replications.
T_1 = 100% Rice, T_2= 100%, Foxtail Millet
P_1= LDPE, P_2= aluminium foil.

Table 6c. Changes in Texture value of during storage

Parameter	**Storage period (days)**				
	0	**2**	**4**	**6**	**8**
T_1P_1	8.80±0.42	8.40±0.39	8.10±0.32	7.85±0.41	7.50±0.41
T_1P_2	8.80±0.42	8.45±0.37	8.10±0.32	7.80±0.42	7.55±0.42
T_2P_1	8.80±0.42	8.50±0.33	8.20±0.42	7.95±0.37	7.75±0.37
T_2P_2	8.80±0.42	8.55±0.28	8.25±0.35	7.90±0.32	7.70±0.32

* Maximum score out of 9. Results are mean value of 10 replications.
T_1 = 100% Rice, T_2= 100%, Foxtail Millet
P_1= LDPE, P_2= aluminium foil.

Table 6d. Changes in Taste value of Haalbaiduring storage

Parameter	**Storage period (days)**				
	0	**2**	**4**	**6**	**8**
T_1P_1	8.20±0.42	7.10±0.21	6.20±0.25	5.20±0.42	4.40±0.45
T_1P_2	8.20±0.42	7.20±0.34	6.25±0.26	5.25±0.35	4.30±0.42
T_2P_1	8.50±0.52	7.50±0.47	6.45±0.37	5.35±0.41	4.60±0.52
T_2P_2	8.50±0.52	7.60±0.39	6.50±0.33	5.40±0.39	4.65±0.47

* Maximum score out of 9. Results are mean value of 10 replications.
T_1 = 100% Rice, T_2= 100%, Foxtail Millet
P_1= LDPE, P_2= aluminium foil.

Table 6e. Changes in Overall Acceptability value of Haalbaiduring storage

Parameter	**Storage period (days)**				
	0	**2**	**4**	**6**	**8**
T_1P_1	8.30±0.48	7.40±0.39	6.50±0.47	5.30±0.42	4.40±0.45
T_1P_2	8.30±0.48	7.50±0.40	6.55±0.49	5.40±0.45	4.45±0.43
T_2P_1	8.60±0.45	7.70±0.48	6.80±0.48	5.70±0.71	4.80±0.48
T_2P_2	8.60±0.45	7.75±0.42	6.80±0.42	5.80±0.63	4.90±0.39

* Maximum score out of 9. Results are mean value of 10 replications.
T_1 = 100% Rice, T_2= 100%, Foxtail Millet
P_1= LDPE, P_2= aluminium foil.

-7. Cost calculation of HaalbaiPer 1 kg of product

Particulars	**Rate (Rs/kg)**	**Quantity (g)**	**Cost (Rs)**
1.Raw material			
a. Foxtail millet	120	500	60.00
b. Coconut	100	500	50.00
c. Jaggery	80	400	32.00
d. Cardamom	3800	1no	3.80
2. Land, rent and depreciation	-	-	20.00
3. Labour charge	30	-	30.00
4. Fuel and packaging	-	-	30.00
Total cost			225.8
5. Profit @ 20%	225.8	-	45.16
6. Total	-	-	270.96
8. Cost (kg) of *Haalbai*	-	-	271

4. Discussion

Millets in India holds a profound cultural significance, being intricately woven into the fabric of religious ceremonies, festivals, traditional medicine, as well as art, literature, and folklore(Ankita and Upasna 2025). Many scholars agree that strong affiliation of millets to the indigenous cultures and traditions may have played a vital role in preserving them and saving the valuable germplasm from local extinction(Mehta, et al., 2024). Millets are eaten as porridge, baked products like bread, boiled rice like products, steamed products, flaked and popped grains. Various other health foods are based on their properties such as gluten-free protein, low glycaemic property, the presence of essential fatty acids, pigments and anti-oxidative property (Sneha and Ritu 2025). In the present study the nutritive value of the product was higher in several important parameters such as moisture, fat and protein in comparison to other studies. Similarly higher mineral composition of Ca was observed. Each of these constituents individually or in combination has major roles in the determining the physico-chemical properties and contribute to the stability of the product. Further, they play roles in health and well-being. Carbohydrates as water-soluble gum-glucans helps in glucose metabolism as a result, millets can be included in a diabetic diet to help with glucose control. Also, millet-based dietary fibre improves glycaemic control, lowers hyperinsulinemia, and lowers plasma lipid contents (Jali et al. 2012; Kamatar et al., 2015).Protein's stability and foaming ability are influenced by its solubility, concentration, and other characteristics (Meherunnahar et al., 2018). Good foam capacity and stability are desired qualities for flours used in the creation of different value-added products. Finally, dietary fibres have several positive nutritional effects on bowel and colon health, blood sugar levels and cholesterol maintenance (Lansakaraa et al., 2016). High-fibre millet diet enhances longevity, health, and well-being. Low calories and high fibre and slow digestion are the accepted norms food industry. Minerals and micronutrients are essential for tissue function maintenance and metabolism and several bodily functions (Sherrill-Bonner 2017). In summary, it could be inferred that Haalabai has well-suited proportions of biomolecules and micronutrients which supports its processing, production and value addition as health promoting product.

The microbial and Mold countin Foxtail halabai was low in comparison to the rice halabai. The lower microbial count could be attributed to the essential oils of *E.*

*cardamom.*A previous study demonstrated ethanolic extracts with significant inhibition of *S. epidermidis* growth ($p<0.001$).Studies also implicate coconut oil to promote anti-bacterial activity. From the results of the study aluminum it could be proposed that aluminum is a well suited packing material or reasons as discussed above. The nine point hedonic scale based organoleptic quality parameters indicated within range parameters and overall acceptance of the Foxtail haalabai was better in comparison to rice halabai.

The existence of millet germplasm has been observed to show a close relationship with local culture globally. The culinary tradition of a society reflects its traditions and depths of taste and adherence to unique food practices (Rai et al., 2025). For example in West Sulawesi Province, Indonesia six traditional millet cultivars (Tarring) with different morphological characteristics have been found in this region and still preserved along with their local culture and traditions(Ramlah et al., 2019). Few traditional foods made by the local people include porridge tarreang, buras tarreang, jepa golla mamea, dodol tarreang used as a symbol in important ceremonies. Data from a similar study in India from Uttarakhand indicates chapattis and porridge of millets flour are frequently consumed in combination with dishes made with pulses and vegetables (Kala and Nautiyal 2022). The dishes are locally called as fanu, chaisu, thechwani, kafli and kadhi.Further, different spices and condiments such as *Allium humile*, *Cleome viscosa*, *Perilla frutescens* and *Cinnamomum tamala*are added to enhance the taste of the dishes. The dishes contain unique characteristics and have ethno-medicinal value.

Several communities of India consume millets in various forms. Few examples include the Gonds consume roti (flat bread) and gatka (porridge) cooked out of Jowar flour as the staple food(Ravula et al., 2022).Popped and puffed seeds of amaranth are cooked as rice, used to prepare laddu after mixing with sugar syrup, or mixed with curd/buttermilk to prepare raita(A.-S. Hager et al., 2012). Kodo millet and Proso millet are cooked like rice, ground to flour for making roti and chilra (pancake) in Himachal Pradesh. Rabadi is an indigenous lactic fermented milk beverage popular in North Western Semi-arid regions of India mainly Rajasthan and Haryana (Gupta and Nagar 2010). Assam's Kokrajhar district's Santali people have been consuming millet as a staple meal, snack, beverage, and sweet dishes such as Kode Dumbu, Belna Pitha, Sunum Pitha(Sarmah et al., 2022). In Uttarakhand, barnyard millet is used to make chencha, a delicious porridge cooked in buttermilk (Chauhan 2023). Several millet based beverages have been used by tribal societies throughout India. Landa and Pej and Sura/ Sur are finger millet drinks consumed by Gadaba tribe of Odisha and in Lug valley of Kullu district, Himachal Pradesh (Mishra et al., 2021; Thakur and Bhalla 2004). Finally, Kodo ko jaanr, also known as Chyang, is a consumed mild-alcoholic beverage in the Sikkim and Darjeeling hills (TamangandKailasapathy 2010).

Haalbai is a sweet which is unique to traditional food of Karnataka as it is prepared in households as a festival sweet or to celebrate special events.It is promoted in Gastronomy tourism in India focusing on exploring food that reflecting the regional, cultural, heritage and tradition (Jayashree et al., 2025). A modified method of *Halubai* preparation which is simple and energy efficient, with good sensory quality is

reported by Asha et al., 2014. Very few food and culinary investigations have been carried out with respect to this product. Hence, there is considerable scope in developing variations of this product. Cardamom fruits (capsules) are used widely as a spice and fragrance and flavoring ingredient in foods and value-added products (Ashokkumar, et al., 2020). The Phytochemical composition is proposed to promote beneficial health properties such as stimulation of digestive enzymes, reduce bloating, and heartburn, and production of bile acids (Jadav and Mehta 2018). The calming aroma helps reduce cortisol levels, which promotes relaxation.Several biological rolesof the capsules includes antioxidant, antidiabetic, antibacterial, anticancer, gastro-protective and insecticidal activities (Jadav and Mehta 2018). Metabolic syndrome (MetS) raises the risk of diabetes mellitus and cardiovascular disease. Recently, there has been a growing interest in using phytomedicine and natural compounds in the prevention and treatment of various diseases. Yahyazadeh et al., 2021 report cardamom has beneficial effects on the treatment of MetS and its complications. The blood pressure lowering property of Cardamom is shown to improve endothelial functions in type 2 diabetic patients. Iqbal et al., 2023 report a poly herbal formula(PHGs) of *Hordeum vulgare*, *Elettaria cardamomum* and *Cicer arietinum* in significantly demonstrated *in-vitro* antioxidant and antidiabetic profiles. Next another ingredient Jaggery activates the digestive enzymes and helps break down food, thus ameliorating indigestion and constipation (Rao et al., 2021). Since jaggery used in Haalbai is made from natural sugars, it is considered safe for consumption in diabetics. Also, it is a good source of Fe, Mg, K, and Zn, which are important for various bodily functions like muscle contractions, nerve function regulate blood pressure and maintain haemoglobin levels (Jomova et al., 2022).A previous report by Ashritha et al., 2022 supports the use of jaggery in millet biscuits for health, promoting of nutrition and consumer acceptance. Thus the natural cardamom ingredient in halabaiis a safe alternative to chemical additives generally used in food industry. Further, they also exhibit several health promoting roles. Coconut milk's is a versatile substitute for dairy milk and provides nutritional benefits such as healthy fats (MCTs), vitamins, and minerals that support heart health and can aid digestion (Liu 2023). Also from a culinary perspective it adds to the Flavor and texture and could be used in a wide range of recipes(Marina and Azizah 2014). It is also shown to promote satiety and raise HDL cholesterol(Ekanayak et al., 2024). Thus halabali has well characterised ingredients used in the preparation which promote human wellbeing through various physiological roles.

Value addition techniques applied to traditional foods can transform them into diverse and appealing products contributing to consumer acceptance, and cross regional barriers and enable nutritional and economic development and food security (Michel et al., 2024).Research has documented the use of millet additions for food and beverage fortification (Chetan Kumar et al. 2022). Millets are high in bioactive antioxidant components which can be added to fruit beverages in place of sugar. FOS and sucralose can then be used to create a low calorie, high-nutrient beverage. RTS (ready-to serve) pomegranate beverage with foxtail addition is reported by Pushpa et al. (2023). Population studies of the impact and acceptability of small-scale and short-term intervention indicate the potential of value added food products made from millets in

filling the nutrition gap arising from the traditional food consumption (Anitha S et al., 2020).

For millet products, costs vary widely based on the product type, scale of production, and processing complexity. In the present study the cost estimation as tabulated in table-7 was for 271rs for 1 kg of Haalbai. Since most ingredients used for preparation of Haalabai are available easily the product can reach several regions and strata of the society. Especially in low income agrarian and societies the product is economical.A study by Nayana et al., 2023 suggests returns per rupee of expenditure in case of value-added products are attractive. Further, the product can be developed and after epidemiological study extended to schoolchildren and diverse communities and people from various illnesses. In summary, the value added food items made from fox millets are practical and affordable solutions for enhancing livelihoods and nutrition security in the lower echelons of the society.

5. Conclusion:

In summary, the product Haalbai has several benefits in terms of health, nutrition. As evident from the nutritional composition analysis higher carbohydrates and protein are higher in Haalbairendering it fit for consumption across ages. Further the active bioactive molecules enable ameliorative properties in several illnesses. Haalbai has several attributes which augurs for a well-balanced Value added product such as economical simple production and cost-effective economics. Indigenous and traditional foods have several benefits in alleviating nutrition, ameliorating health and also support employment and finances in low-cost settings. Cumulatively, these research data suggest the product can be promoted as a traditional nutritional supplement to community after epidemiological studies.

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References:

1. Hager, A.-S., Zannini, E. and Arendt, E.K (2012). Woodhead Publishing Series in Food Science, Technology and Nutrition, Breadmaking (Second Edition).Formulating breads for specific dietary requirements. Page. 711-735.
2. AACC. 2000.Aproved Methods of the American Association of Cereal Chemists, 10th edition American Association of Cereal Chemist. Inc. St, Paul, Minnesota.
3. Haji, A., Tilahun, A. T., Tizazu, Y. B., Tess, A., Henock, W. W. andMarkos, M. U (2024). Journal of Agriculture and Food Research.Effect of processing methods on the nutrient, antinutrient, functional, and antioxidant properties of pigeon pea (Cajanuscajan (L.) Millsp.) flour. Volume 18: Page.101493.
4. Anitha, S., Htut, T. T., Tsusaka, T. W., Jalagam, A. and Kane-Potaka, J. (2020). Journal of the Science of Food and Agriculture. Potential for smart food products

in rural Myanmar: use of millets and pigeonpea to fill the nutrition gap. Volume100 Issue 1: Page. 394-400.

5. Ankita. and Upasna, S. (2025).Journal of Ethnic Foods. Millets in India: exploring historical significance, cultural heritage and ethnic foods. Volume 12 Number 1: page. 2.
6. AOAC 2000. Association of Official Analytical Chemists, Official methods of analysis. 20th edition. Gaithersburg. Maryland.
7. Arora, L., Aggarwal, R., Dhaliwal, I., Gupta, O. P., &Kaushik, P.(2023). Frontiers in Nutrition. Assessment of sensory and nutritional attributes of foxtail millet-based food products. Volume 10: Page. 1146545.
8. Asha, M. R., Ravi, R., Srinivasan, B. K., RaoPatil, S. B., andPrakash, M. (2014). Journal of food science and technology. Modified method for preparation of Halubai—an Indian traditional sweet. Volume 51 Number 4: Page. 743-749.
9. Ashritha, B., Anila, K. E., Jyothsna and Srinivasulu, M. (2022). Biological Forum – An International Journal. Sensory Evaluation and Consumer Acceptance of Jaggery Based Minor Millet (Foxtail and Little Millet) Biscuits. Volume 14 Number 4:Page. 628-633.
10. Kumar, B., Singh, M., Kumar, A., Kumar, D., Singh, A. K., Kumar, R. and Kumar, S. (2024). Intech books. Finger Millet Scientific Cultivation and Its Uses in India. Volume 10: Page. 5772.
11. Gochhayat, C. K. and Chhabra, V. (2025). International Journal of Agriculture Extension and Social Development. Millets: Past, present and future.Volume 8 Number 5;Page. 493-503.
12. Chauhan, D., Sethi, L., Tyagi, M. and Sharma, S., (2023). Journal of Drug Research in Ayurvedic Sciences. Millets: The sustainable ancient super food for the modern world. Volume 8 Supplementary 1: Page.S34-S41.
13. Deshwal, G. K. and Panjagari, N. R. (2020). Journal of Food Science and Technology. Review on metal packaging: materials, forms, food applications, safety and recyclability. Volume 57 Number 7: Page. 2377-2392.
14. Mehta, D., Vyas, S., Dudhagara, D., Patel, A., and Parmar V. (2024). Trends in Food Science & Technology. Significance of Indian millets in enhancing global food security: A comprehensive review. Volume 149: Page.104527.
15. Ekanayaka, R.A., de Silva, P.G.S.M., Ekanayaka, M.K., Jayathilake, W.M.M., Pathirana, R.P.M.M.R., Amaratunga, Y.N., De Silva, P.J. and Perera, B. (2024). Global Epidemiology. Effect of different forms of coconut on the lipid profile in normal free-living healthy subjects: A randomized controlled trial (Phase II). Volume 7: Page.100138.
16. Gowda, N.A.N., Siliveru, K., Prasad, P.V.V., Bhatt, Y., Netravati, B.P. and Gurikar, C. (2022). Foods 2022. Modern Processing of Indian Millets: A Perspective on Changes in Nutritional Properties.Volume 11: Page.499.
17. Gupta, V. and Nagar, R. (2010). Journal of Food Science and Technology. Effect of cooking, fermentation, dehulling and utensils on antioxidants present in pearl millet rabadi—a traditional fermented food. Volume 47: Page.73–76.
18. Harrigan, P. S. and Maccance, M.E. (1966). Laboratory Methods in Microbiology. Academic Press, London: Page.14-16.

19. Iqbal, R., Azhar, I., Iqbal, M.N., Hamid, I., Zahoor, M., Akhtar, M. F., Mahmood, Z. A., Ullah, R., and Alotaibi, A. (2023). Heliyon.Chemical characterization, antioxidant and antidiabetic activities of a novel polyherbal formulation comprisingof Hordeumvulgare, Elettariacardamomum and Cicerarietinum extract s. Volume 9 Number 9:Page. 1-12.
20. Jacob, J., Krishnan, V., Antony, C., Bhavyasri, M., Aruna, C., Mishra, K., Nepolean, T., Satyavathi, C. T., Visarada, K.B. (2024).Frontier in nutrition.The nutrition and therapeutic potential of millets: an updated narrative review. Volume 30 Number 11: Page. 1346869.
21. Jain, V., Agarwal, N. and Bhatia, V. (2024). Indian Journal of Community Medicine. Promoting Millets: Charting a Journey from Food Security to Health. Volume 49 Number 1: Page.5-10.
22. Jali, M. V., Kamatar, M. Y., Jali, S. M., Hiremath, M. B., &Naik, R. K. (2012).Recent Research in Science and Technology. Efficacy of value added foxtail millet therapeutic food in the management of diabetes and dyslipidamea in type 2 diabetic patients. Volume4 Number 7: Page. 3-4.
23. Jayashree,N. and Byrappa,M. G. and Patil, S. J. (2025). Festival and Event Tourism and Hospitality Series. Gastronomy Tourism in India with Special Reference to Maharashtra and Karnataka. Page. 156–165.
24. Sahoo, J. P., Swapna, D., Mohanty, A., Naik, B.,Pratyasa, P., Akankshya,S., Mohapatra, Sahoo, D. and Nayak, B. (2025) Bhartiya Krishi Anusandhan Patrika. Unlocking the Health Potential of Foxtail Millet: Phytopharmacology, Bioactive Compounds and Therapeutic Applications: A Review.Page. 1-10.
25. Kala, C.P. and Nautiyal, S. (2023). Journal of Social and Economic Development. Traditional food knowledge of local people and its sustainability in mountains of Uttarakhand State of India.Volume 25 Number 1: Page.32-51.
26. Kumar, K. A., Murugan, M., Dhanya, M. K. and Thomas D. W. (2020). Journal of Ethnopharmacology. Botany, traditional uses, phytochemistry and biological activities of cardamom [Elettariacardamomum (L.) Maton] – A critical review.Volume 246.
27. Kamatar, M. Y., Brunda, S. M., Rajaput, S. andHundekar, R. (2015). International Journal of Engineering Research & Technology. Nutritional composition of seventy five, elite germplasm of foxtail millet (Setariaitalica). Volume 4 Number 4: Page. 1-6.
28. Kheya, S. A., Talukder, S. K., Datta, P. Y. S., Rashid, M. H., Hasan, A. K., Anwar, M. P., Islam, A. A. and Islam, A. M(2023). Heliyon. Millets: The future crops for the tropics - Status, challenges and future prospects. Volume 9 Number 11.Page. 1-16.
29. Jadav, K. D. and Mehta, M. M. (2018). Journal of Dairy Science and Technology. Cardamom: Chemistry, Medicinal Properties, Applications in Dairy and Food Industry: A Review Research and Reviews. Volume 7 Number 3.Page. 9-19.
30. Jomova, K., Makova, M. Alomar, S. Y.,Alwasel, S. H., Nepovimova, E.,Kuca, K., Rhodes, C. J. and Valko, M. (2022). Chemico-Biological Interactions. Essential metals in health and disease. Volume 367: Page. 110173.

31. Kumar, V., Yadav, M., Awala, S.K., Valombola, J.S., Saxena, M.S., Ahmad, F. and Saxena, S.C., (2024). Planta.Millets: A nutritional powerhouse for ensuring food security. Volume 260 Number 4: Page.101.
32. Sudha, K. V., Karakannavar, S. J.,Inamdar, B. and Yenagi, N. B., (2022). The Pharma Innovation Journal. Shelf life study of foxtail millet (Setariaitalica) based laddu. Volume 11 Number 4: Page.1608-1612.
33. Lansakara, L.H.M.P.R., Liyanage, R., Perera, K., Wijewardana, I., Jayawardena, B. and Vidanarachchi, J. (2016). Procedia Food Science. Nutritional composition and health-related functional properties of Eleusinecoracana (Finger Millet).Volume 6: Page.344-347.
34. Yousaf, L., Hou, D., Liaqat, H. and Shen. Q. (2021). Food Research International. Millet: A review of its nutritional and functional changes during processing.Volume 142: Page.110197.
35. Yue, L., Sang, L., Mao, H., Maimaiti, Z., Wang, J., Zhang, T., Wang, X., Yu, M. and Shen, Q., (2025).LWT, Structural and physicochemical properties of foxtail millet and its noodle-making potential. Page.118214.
36. Liu, W. (2023).Journal of Nutrition and Food Science.The Nutritional Elixir: Unveiling the Benefits of Coconut Milk. Volume 13:Page.60.
37. Marina, A. andNurul,A. S. (2014). Journal of Food and Nutrition Research.Use of Coconut Versus Dairy Milk Products in Malaysian Dishes: Comparison of Nutritional Composition and Sensory Evaluation. Volume 2: Page. 204-208.
38. Meherunnahar, M., Chowdhury, R. S., Hoque, M. M., Satter, M. A., and Islam, M. F. (2018). Progressive Agriculture. Comparison of nutritional and functional properties of BK2 foxtail millet with rice, wheat and maize flour. Volume29 Number 2:Page.186-194.
39. Mishra, A. K., Bajpai, R. and Swain, A. (2021). Biodivers Journal of Biological Diversity.Finger millet-based staple beverages con sumed by the Gadaba ethnic community of Odisha, India: preparation and nutritive characteristics. Volume 22. Number 5.Page. 2737-2742.
40. Munshi, M., and Dashora, K. (2024). Measurement: Food. Comparative study of physico-chemical composition, functional, morphological and pasting properties of major and minor millet flours as a gluten free alternative to wheat flour. Volume 16. Page. 100202.
41. Nayana, H. N., Umesh, K. B.,Ramu, M. S. and Sadhana, H. S. (2023). The Pharma Innovation Journal.Production and value addition of climate-smart millets:An economic analysis in eastern dry zone of Karnataka,India. Volume 12 Number 10:Page.1972-1976.
42. Choudhary,N. P. and. Kumar D. T. (2024). Journal of Food Science and Technology.A Process optimization of pearl millet-based fermented beverage components using response surface methodology and evaluation of its physicochemical parameters. Volume 61 Number 8: Page.1557-1568.
43. Newmaster, S. G., Ragupathy. S., Dhivya, S., Jijo, C. J., Sathishkumar, R. and Patel, K. (2013). Genome.Genomic valorization of the fine scale classification of small millet landraces in southern India. Volume 56 Number 2: Page. 123.

44. Ayin, P., Gupta, A., Verma, T. and Mishra, P. (2021). International Journal of Home Science. Organoleptic and nutritional evaluation of value added food products incorporated Houttuynia Cordata, Figer Millet and foxtail millet.Volume 7 Number 3:Page. 167-171.
45. Pandey, P., Malagi, U., Yenagi, N. and Dhami, P. (2017). International Journal of Current Microbiology and Applied Sciences. Evaluation of Physico-Functional, Cooking and Textural Quality Characteristics of Foxtail Millet (Setariaitalica) Based Vermicelli. Volume6 Number 10:Page.1323-1335.
46. Pramitha, L., Choudhary, P., Rana, S., Singh, R. K., Das, P., Sharma, S., Rajasekaran, R., Prasad, M. and Muthamilarasan, M. (2023). Academic Press. Foxtail millet (Setariaitalica L.): a model for small millets. In: Neglected and underutilized crops. Page. 305–324.
47. Sarkar, P., Dh, L.K., Dhumal, C., Panigrahi, S.S. and Choudhary, R., (2015). Journal of Ethnic Foods. Traditional and ayurvedic foods of Indian origin. Volume 2 Number 3. Page.97-109.
48. Kumar, P. C., Sundararajan, A., Oberoi, H. S. and Karuppiah, P.(2022).The Pharma Innovation Journal. Quality parameters of foxtail and little millet incorporated fruit beverages. Volume 11 Number 3: Page. 324-331.
49. Kumar, P. C., Sundararajan, A., Oberoi, H. S. and Vellaikumar, S.(2023). Journal of Applied Horticulture. Quality evaluation of artificially sweetened millet flour incorporated pomegranate RTS beverage. Volume25 Number 1: Page.69-73.
50. Raghuramulu, N., Nair, M., K. And Kalyansundaram, S.(1983). A manual of laboratory techniques. National Institute of Nutrition, Hyderabad, India.
51. Rai, M., Yap, S. F., Yang, L., and Stewart, C. (2025). Journal of Marketing Management. Preserving tradition amidst modernity: the hybridity of food practices. Volume 41 Number (9–10): Page.978–1001.
52. Ramlah, P.M. and Daryono, B.S. (2020). Biodiversitas. Local food diversification of foxtail millet (Setariaitalica) cultivars in West Sulawesi, Indonesia: A case study of diversity and local culture. Volume21 Number 1: Page. 67-73.
53. Rao, G. P. and Singh, P. (2022). Sugar Technology. Value Addition and Fortification in Non-Centrifugal Sugar (Jaggery): A Potential Source of Functional and Nutraceutical Foods. Volume 24 Number 2: Page.387-396.
54. Ravula, P., Kasala, K. and Chakraborty, A., (2022). Folk Life. Farming, festivals, and food cultures among indigenous communiies in Telangana, India. Volume 60 Number 2: Page.115–34.
55. Sarmah, P. and Roy, B. (2022). The Pharma Innovation Journal. Millet based ethnic food products consumed by Santali community of Kokrajhar district of Assam. Volume 11 Number 12: Page. 55–58.
56. Shergill-Bonner, R. (2017). Paediatrics and Child Health. Micronutrients. Volume 27 Number 8:Page.357-362.
57. Kumari, S. (2023).Journal of Nutrition and Food Processing.Miracles of Indian Traditional Foods: Nutritional Quality of Millets and Their Traditional Products with Potential Health Benefits. Volume 6 Number 6.

58. Siripurapu, K. K. and Singhdeo, A. K. (2019). The little millet beer—traditional beverage of the indigenous Kutia Kondh Community of Odisha. RRA Network, India.
59. Hiregoudar, S. andMamatha, H. S. (2022). Environment and Ecology. Evaluation of Physico-chemical Properties of Foxtail Millet (Setariaitalica) Based Biscuits. Volume 40 Number 2B: Page. 721—727.
60. Srilaxmi, B. (2010). Food Science, New Age International Publisher, 6th Edition: Page. 319-320.
61. Spengler, R. N. (2019). Fruit from the sands: the silkroad origins of the foods we eat. University of California Press.
62. Srivastava, Sneha ,Sureka and Ritu. (2025). The Ancient Grain. Millets: The Ancient Grain. Volume II: Page.1-15.
63. Tamang, J. P. and Kailasapathy, K. (2010). Boca Raton. Fermented foods and beverages of the world. CRC Press.
64. Thakur, N and Bhalla, T. C. (2004). Indian Journal of Traditional Knowledge. Characterization of some traditional fermented foods and beverages of Himachal Pradesh. Volume 3 Number 3: Page. 325–335.
65. Sadhu, V. J. and Naidu. S. (2021). Food & Nutrition Journal.A Study on Functional and Nutritional Characteristics of Barnyard Millet and Foxtail Millet. Volume 6:Page. 234.
66. Warisa, S., Debbarma, A., Hazarika, A. and Nath, A.J., (2025). Discover Soil. Millet cultivation in India: geographical distribution, nutrient management practices, and policy implications. Volume 2 Number 1: Page. 12.
67. Roghayeh, Y. (2021). Iranian Journal of Basic Medical Sciences.The effect of Elettariacardamomum (cardamom) on the metabolic syndrome: Narrative review. Volume 24. Page.1462-1469.
68. Zhu, Y.U., Chu, J., Lu, Z., Lv, F., Bie, X., Zhang, C. and Zhao, H., (2018). Journal of Cereal Science. Physicochemical and functional properties of dietary fiber from foxtail millet (Setaria italic) bran. Volume 79: Page. 456-461.