



A Case Study on Different Foxtail Millet Based Food Recipes in Arunachal Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The foxtail millet is a major crop grown in state of Arunachal Pradesh, India. This crop falls under millet; which is now treating as most important grain for human health. Different studies have proven that foxtail millet has good amount of antioxidants which is beneficial for human health. The team of Farm Science Centre, district- Tirap, Arunachal Pradesh, India carried out a research programme during July- August, 2023 in six villages. Ten person per village were interviewed (who were involved in cooking of foxtail millet recipes) and a total sixty persons were interviewed during the course of study. The local name of foxtail millet, different names of recipes made by its and their ingredients (local herbs, spices, vegetables) method of preparation of recipes were asked in detail with selected farmers. Team founded that total 12 recipes are prominently consumed by tribal peoples in the selected area.

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1. INTRODUCTION

Known as dryland cereals, millets are the cereals that aren't the main crops like wheat, rice, and maize. For millions of people, particularly those who live in hot, arid climates, they constitute a vital source of sustenance. Under many undeveloped and underdeveloped nations, their capacity to thrive under adverse climatic conditions makes them a reliable source of food.

Dry land agriculture relies heavily on them since they need little to no purchased inputs. Nutri-cereals, as millets are called, are gluten-free, rich in protein and antioxidants and have a low glycaemic index, all of which can help prevent or manage diabetes [1].

The production of millet reached approximately 712 lakh ha and production 863 lakh ton worldwide in 2019 while India has an area of 138 lakh ha with 173 lakh ton (Table 1). Sorghum (or large millet), pearl, proso, foxtail, barnyard, small, kodo, brown top, finger and Guinea millets are examples of the diverse group of grains known as millets. Due to their genetic diversity, millets can be used to generate money for both professional applications like pharmaceuticals and therapies as well as food-related businesses [2].

Up-to last decades, the millets have been neglected like food of poor people but in the current decade after positive results of different studies on millets, the significance importance of millets has been proven in society [3,4]. The second-most popular millet variety and the most significant in East Asia is foxtail millet (*Setaria italica*). Other names for foxtail millet are Thanai (Tamil), Korralu (Telugu), Navane (Kannada), Italian, German, Chinese, and Hungarian millet. It has been documented that foxtail millet has been cultivated in China since 6th millennium BC; which is oldest as per documents Thathola et al. [5].

According to reports [1], (Yang et al., 2012), millets are super nutritious and have a variety of medicinal uses. Due to their higher protein, calcium, dietary fibre, and polyphenol content, millets are preferable to cereals [2]. On average, millets have a larger fat content than maize, rice and sorghum and contain significant levels of important amino acids, especially the sulphur-containing amino acids (methionine and

cysteine) [1]. Because magnesium and phosphorus are found in millets in sufficient amounts, they can help lessen the effects of migraines and heart attacks (because of the magnesium) and phosphorus is necessary for the body to produce adenosine triphosphate (ATP), which is a precursor to energy [6,7,2].

Foxtail millet oil's general characteristics and fatty acid profile were published in Liang et al. [7] 's work. Amadou et al. [8] and Liang et al. [7] have demonstrated that millet oil has the potential to be a valuable natural oil source that is high in tocopherols and linoleic acid. According to Thathola et al. [5], foxtail millet, a low GI dietary product, improves type 2 diabetics' long-term glycaemic and lipidemic management mildly.

Beyond being a stand-in for ordinary grains, millets offer more. Their effects on health are positive. Numerous phytochemicals are found in millets, such as phytate, linked to a lower risk of cancer, and phytic acid, which is thought to lower cholesterol [9]. Being gluten-free, millet is a great alternative for those with celiac disease who are frequently aggravated by the gluten in wheat and other more popular cereal grains [10-13].

According to Gélinas et al. [14], it is also beneficial for those with diabetic heart disease and atherosclerosis. In comparison to a casein diet, the protein concentrates of Korean foxtail millet and proso millet markedly increased plasma adiponectin and HDL cholesterol levels and caused significant decreases in insulin levels in type 2 diabetic mice, according to studies by Choi et al. [15] and Park et al. [16]. A study using the 1, 1, Diphenyl -2- picrylhydrazyl (DPPH) method demonstrated the significant antioxidant activity of various millets, including kodo millet, finger millet, little millet, foxtail millet, barnyard millet (kudiraivali), great millet (jowar), and their white varieties [17,18]. Also, distinct radical scavenging capabilities of fractionated foxtail millet protein hydrolysate were found by Kamara et al. [19]. A decade ago, this was one of the staple foods of the people in Southern India (Rayalaseema and Telangana). It is prepared similarly to rice. Because it's healthier than rice, foxtail millet is once again finding a home on our plates. In order to substitute rice and wheat rawa, foxtail millet has thus been used in different types of product development.

Table 1. World wide millet production data

Region	Area (Lakh ha)	Production (Lakh ha)
Asia	162	215
America	489	423
Australia & New Zealand	6	12
America	53	193
Europe	8	20
India	138	173
World	718	863

(Source: FAO statistics, [20])

In Arunachal Pradesh foxtail millet known as “Koni dhan” in local dialect. During seventies and eighties, it was the staple food of Arunachal Pradesh but now after the introduction of high-yielding rice cultivars as well as Public Distribution System; its consumption has been reduced. But still foxtail millet is an important constituent of daily diet in Arunachal Pradesh. It has several uses in local dishes of tribals-cooking as rice, cooking with rice, khichdi, laddu, cooking with local fishes, cooking with different types of meats etc. are different dishes cooked by tribals in the region.

2. MATERIALS AND METHODS

The study was carried out during July- August, 2023 in six villages (Natun Kheti, Thinsa, Upper Kolam, Lapnan, Otongkhwa and Kanubari) of Tirap and its neighbouring district – Longding, Arunachal Pradesh. The Tirap district is dominated by Nocte tribe while Tutsa, Wangchu and Tangsa are minor tribes; which also prevail

in the district. In Longding district- Wangchu is the major tribe. The selected villages elevated from 400 meter to 1200 meter from mean sea level (MSL). Every tribe has their own dialect, ethnicity, customs, socio- cultural systems, food habits etc.

The team of Farm Science Centre (Krishi Vigyan Kendra) - Tirap, Arunachal Pradesh collected the primary data from different selected villages with the help of villagers and Gaon buras (GB- Village head). Ten person per village were interviewed (who were involved in cooking of foxtail millet recipes) and a total sixty persons were interviewed during study. The local name of foxtail millet, different names of recipes made by its and their ingredients (local herbs, spices, vegetables) method of preparation of recipes were asked in detail with selected farmers (Table 2). Selected farmers were also asked about health benefits of foxtails millet, occasion of cooking etc. The information was collected and recorded in semi- structured manner.

Table 2. Foxtail millet-based recipes and their details

SN	Name of Recipe/ food item	Ingredients	Preparation process
1	Foxtail millet alcoholic beverage; locally known as Jumin	Foxtail millet grains, Bichhi (starter having yeast)	<ul style="list-style-type: none"> • Cooking of foxtail millet grains like rice and spread it for cooling • Mixing a powder of herb; obtained by local local plants called BICHHI for starting fermentation • Putting this mixture up-to 2 days in any cane/pot by pressing well • After 2 days, the mixture should be kept in jute bag and again put into pot • The fermented product will sieve from jute bag and accumulate in pot. • After properly sieving the final product: Jumin is ready
2	Foxtail millet Soup	Foxtail millet powder, carrot, beans, salt, local ginger, garlic, corn flour, black pepper powder, black salt, vinegar and butter	<ul style="list-style-type: none"> • Mixing of millet powder and corn powder well • Heating of refined oil in pan and roasting in garlic and ginger up-to 1 minute • Roasting of vegetables at medium flame up-to 5 minutes • Adding vinegar, black pepper and salt and stirring well up-to 5 minutes; at low flame • Adding water & mix powder of millet + corn with proper

SN	Name of Recipe/ food item	Ingredients	Preparation process
			steering and cooking well for 5 minutes. <ul style="list-style-type: none"> • Soup is ready, add butter and serve it
3	Foxtail millet Momo	Foxtail millet flour, wheat flour, meat, salt, seasonal vegetables, local spices and herbs, oil,	<ul style="list-style-type: none"> • Preparation of wrapper by mixing of millet flour plus Maida with water and making good quality dough • Making small ball size • Preparation of stuffing pre-cleaned and washed ingredients by chopping in small pieces and mixing well each other • Rolling of balls up-to 4-5 inches round shaped and filling stuffs and sealing well • Steaming of these uncooked momos till cooking and cooling
4	Foxtail millet Chapati	Foxtail millet flour and wheat flour (60:40)	<ul style="list-style-type: none"> • Kneading dough with adding water by hand • Make round ball and spread in into round shape by stick • Bake it to both side on pre-heated Tawa
5	Foxtail millet Khichdi	Foxtail millet grains, pulse, seasonal vegetables, local ginger, garlic, onion, green chilli, salt, turmeric powder, mustard oil	<ul style="list-style-type: none"> • Soaking of pulse for 30 minutes and washing of millet grains • Heating of mustard oil in a pan and add chopped green chilli, onion & garlic up-to light brown colour • Add chopped vegetables, turmeric powder, salt on low flame up-to 5-6 minutes and adding of pulse & millet • Cook up-to 20 minutes
6	Foxtail millet Pulaaw	Foxtail millet grains, seasonal vegetables, local ginger, onion, garlic, salt, turmeric powder, red chilli powder, large cardamom, garam masala powder, mustard oil and ghee	<ul style="list-style-type: none"> • Cleaned grains should be rinsed • Green chilli, large cardamom & onion should be fried in heat mustard oil and add ginger past later • Add chopped vegetables, turmeric powder, chilli powder and salt and cook up-to 5 minutes • Add water and cook up-to rolling boil condition • Add garam masala powder and cooking up-to 30 minutes at low flame with covering the pan
7	Foxtail millet Biscuit	Foxtail millet flour, Maida, baking powder, sugar, butter	<ul style="list-style-type: none"> • Mixing of pre-sieved millet flour and Maida well and adding of butter & sugar for a good texture • After good dough condition, rolling and making small ball final product • Shaping with hand and putting in baking tray • Putting trays in oven up-to 15 minutes at 180 °C and cooling and packing
8	Foxtail millet Cake	Foxtail millet flour, Maida, sugar powder, milk, baking soda, Choco powder, egg	<ul style="list-style-type: none"> • Mixing of pre-sieved millet powder and Maida well • Mixing well of egg and butter till attaining of creamy texture then mixing of sugar, milk and Choco powder well • Making a good quality of batter with mixing baking powder and baking soda • Stirring well for uniform texture • Putting batter in baking bowl and placing in oven for 30 minutes @ 180 °C • Taking baking bowl out side and allow it for cooling and now cake is ready
9	Foxtail millet Kheer	Foxtail millet grains, sugar, milk, dry fruits	<ul style="list-style-type: none"> • Washing of millet grains • Heat the milk up-to boiling and add washed millet, dry fruits leave for 5 minutes for cooking • Cooking for 5 minutes; after adding of sugar
10	Foxtail millet Halwa	Foxtail millet flour, sugar, milk, ghee, dry fruits, small cardamom	<ul style="list-style-type: none"> • Heating of ghee at low flame and light roasting of dry fruits • Then roasting of millet flour in ghee and adding and boiling of milk; steering is required during cooking to avoid lumps • After solidification; add sugar and cook for 5 minutes and

SN	Name of Recipe/ food item	Ingredients	Preparation process
			cover the pan with lid
11	Foxtail millet Laddu	Foxtail millet flour, sugar, ghee, dry fruits, small cardamom, coconut powder	<ul style="list-style-type: none"> • Roasting of millet powder in preheated pan up-to 3 minutes and cool it after turning light brown colour • Boiling of sugar till making syrup form • Heating of ghee in pan & adding of cardamom, coconut powder and pre roasted millet powder and mix well • Add pre cooked syrup and mix thoroughly and make round balls by hand
12	Foxtail millet Samosa	Foxtail millet flour, Maida, salt, potato, green chilli, ginger, garlic, ajwain oregano, refined oil	<ul style="list-style-type: none"> • Properly mixing of millet flour and Maida, oregano, refined oil, water and making it good quality dough • Cutting to dough into small sized balls • Making a good quality mixture by cooking of potato and further mixing salt, chilli, ginger, garlic etc • Rolling of pre-cutted balls into 5-6 inches circles and cutting by half • Again, spreading half cutted dough and filing the mixture and shaping it well • Heat the refined oil in pan up-to full boiling point and placing samosas and cooking up-to turning light brown colour • Turning over after 5-6 minutes is required for well cooking • Putting out side from pan after becoming light brown in colour by ladle

3. RESULTS

As per nutritional value and culinary benefit of foxtail millet, the total 12 different food recipes were explored and documented from Nocte tribe of Tirap district in Arunachal Pradesh. These recipes reflecting a diverse arena of cooking style like- boiling, steaming, roasting, frying; which results different flavors textures during end products.

- 1. Foxtail millet beverage called Jumin:** This is a alcoholic beverage; which is the very popular in ethnicity of Nocte Tribes. Jumin is drunk by every tribals on daily basis. This is also offered for welcoming of any guest.
- 2. Foxtail millet Soup:** Soup is very popular in tribal society of North- east region of India as well as whole South East Asia. The foxtail millet flour used by Nocte tribes to cook the soup.
- 3. Foxtail millet momo:** As the part of Mongolian races, Nocte tribals fond of this dish. Flour of foxtail millet is used to cook the momo which is abundantly grow in district.
- 4. Foxtail millet Chapati:** As the effect of globalization and demographic effect; now chapati is also becoming the popular among tribals of North- east India despite of staple rice eating. The flour of foxtail

millet mixed with wheat flour in ratio of 50:50 for making chapati.

- 5. Foxtail millet Khichdi:** Being a boiled food eating habit of tribals of North east India, the grains of foxtail millet cooked with local vegetables and eat. But sometimes they also cook khichdi with using of oils, spices.
- 6. Foxtail millet Pulaaw:** This food is very famous among youths of Nocte tribes. During the party of occasionally, they cook the pulaaw.
- 7. Foxtail millet Biscuit:** In the row of fast development, biscuit is the part of daily routine in every corner of globe. Similarly, tribal women cook biscuits by using flour of foxtail millet and mixing with wheat flour/maida.
- 8. Foxtail millet Cake:** The cake is also getting popular among Nocte tribe. Women uses flour of foxtail millet to cook it. Especially during birthday or anniversary; tribal women cook this dish.
- 9. Foxtail millet Kheer:** As the effect of communication, kheer is also getting popular among Nocte tribals. The grains of foxtails millet are cooked with milk and eat by children daily basis.
- 10. Foxtail millet Halwa:** Being easy less time-consuming, halwa is also getting popular among tribals of Tirap district. Flour of foxtail millet are cooked solely or mixed with wheat flour for this recipe.



Fig. 1. Some glimpses of milletbased recipes programmes conducted by Krishi Vigyan Kendra-Tirap, Arunachal Pradesh

11. **Foxtail millet Laddu:** Foxtail millet laddu has been introduced by some Help help groups in the district. It is becoming popular gradually.
12. **Foxtail millet Samosa:** This product of foxtail millet has become very popular in the region due to the health benefits of foxtail millet.

4. DISCUSSION AND CONCLUSION

In the general population, millets are referred as "Marwa." However, it goes by many various names among different tribes: Sase in the

Apatani tribe, Kongpu in the Monpa tribe, Yamba in the Idu Mishmi tribe, Tami in the Galo tribe, Mirung in the Adi tribe, and Tami, Temm, or Tyme in the Nyishi tribe. Meanwhile Foxtail millet is generally known as "Koni dhan" in entire North-eastern region of India. This study has documented the uses of Foxtail millet in the form of traditional food as well as its uses in cooking modern-era recipes too. The Jumin is very popular foxtail millet product; uses in every household in foxtail millet cultivating area in the region as well as consumed by most of the population as alcoholic beverage. A special version of Jumin is also offered by tribal people

to their guest. Similarly, khichdi, soup, chapati, pulaaw are the old recipes which are consumed in daily basis. Chincholikar et al. [21] mentioned that foxtail millet has an extent quality of dietary fiber, iron, protein, calcium and essential amino acids. Thus, the recipe's combination of old vs new are showcasing their culinary utility, utility etc. The uses of foxtail millet-based recipes with low glycaemic index to cater the diabetics, showcases how traditional ingredients are adapted to specific dietary needs [15].

Arunachal Pradesh is the second-largest millet-producing state in the northeast, but most of the millet grown there is consumed locally and with millet-based items mostly found in small-town /marketplaces. The use and production of millet in the area are therefore unknown to many people. Millets are used by farm animals as feed in addition to being a food source for human use.

This lack of knowledge may be attributed to the belief that millet production is only found in dry and desert areas. Because millet is typically produced on Jhum fields in the area, people may decide not to cultivate millet as a result of the government's discouragement of shifting (Jhum) farming [22,23]. The decreasing inclination towards millets among the inhabitants of Arunachal Pradesh can be attributed to these and other factors.

There is mentioned in Ayurveda system of medicine that the diet and lifestyle are positively correlated [21]. Hence good food habit can inhibit the disease in human life. In this context documentation and exploration of millet-based recipes can encourage to millet growers about its nutritional value as well as culinary versatility. As we know that Food and Agriculture Organization (FAO) had declared "International year of millet-2023" during last year; so many awareness programs on millets had conducted among common public at world level. After this the common people of globe knew the health benefits and they have started to consume millet in any kind in their daily diet. This is enhancing the scope of millet demand as well as popularity in every corner of world. By this way millet is getting their valuable importance.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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