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Nutritional profile and health benefits of Teff: A review

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Abstract
In recent times, there has been a noticeable rise in consumer awareness regarding health issues linked to nutrition. As a result, a majority of individuals are taking active steps to embrace healthier lifestyles by adopting well-rounded eating habits. Teff (*Eragrostis tef*), a staple crop indigenous to Ethiopia, is transforming its utilization. Formerly lesser-known for human consumption due to limited awareness, Teff has gained significant popularity due to its impressive nutritional profile. Teff stands out as a source of essential nutrients, including carbohydrates, proteins, dietary fiber, calcium, and iron. Notably, its gluten-free nature makes it a valuable inclusion in diets designed for individuals with celiac disease. The versatility of Teff extends to the food industry, where it can serve as a promising substitute for developing nutrient-rich products. Moreover, in Ethiopia, the traditional dish known as Injera, a time-honored favorite, has been enjoyed by generations. Teff's growing recognition for its nutritional benefits positions it to significantly influence healthier eating choices.

Keywords: Teff, nutrition profile, amino acids, health benefits, value added products

Introduction
Teff (*Eragrostis tef*) is a gluten-free tropical native cereal of Ethiopia belonging to the family Poaceae, and genus Eragrostis (Viell *et al*., 2020) [1]. Teff is also known as lovegrass and annual bunch grass in English. It is said to have originated from the Amharic term "Teffa," which means "lost," because of the grain's small size (1-1.5 mm) and ease with which it can be lost if spilled (Alfy *et al*., 2012) [2]. Teff was domesticated in Ethiopia approximately 3000 years back. So far over 4000 varieties of Teff plants have been identified in Ethiopia and are classified into three classes such as red, white, and mix (brown and white) (Andreotti *et al*., 2022) [3].

Teff is the most low-risk crop to cultivate in a wide range of ecological conditions such as harsh environmental conditions hence it is considered as the most stress-free and pest-free crop (Gebru *et al*., 2020) [4]. Cultivated by over five million small-scale farmers annually, Teff constitutes the staple diet for more than half of the 80 million population, making it a fundamental food source. Its advantageous traits are appreciated by both farmers and consumers, contributing to its popularity (Nascimento *et al*., 2018) [5]. In the past few years, the cultivation of Teff has effectively expanded to various regions across the world, including the USA, India, and Australia.

Teff is one of the minor millets grown in India. It can be grown in unfavourable soil and weather conditions and adapts to a variety of cropping systems by offering nutrient-rich grain and feed. Teff has higher concentrations of copper, iron, calcium, phosphorus, and thiamine. It has become known as a high-energy, nutrient-dense diet that reduces malnutrition, treats diabetes and obesity, and serves as a substitute for celiac patients (Akansha *et al*., 2018) [9].

Teff grains are highly nutritive and contain unique dietary benefits due to their gluten-free nature. Teff is used in the preparation of injera, a primary public dish (Tadele & Hibistu 2022) [6]. Apart from the consumption Teff is also used as animal feed and mixed with mud for building purposes (Minten *et al*., 2016) [7].

***Source*:** Indian Institute of Millets Research, 2023

Fig 1: Teff plant

Nutritional profile

Carbohydrates: The total carbohydrate of Teff includes all monosaccharides, disaccharides, oligosaccharides, polysaccharides, and total dietary fibre. Generally, the carbohydrate content of the Teff varieties ranges from 83-86g/100g (Yilmaz & Arslan 2018) [8]. The total carbohydrate content of the Teff is found to be 85.6% and the starch content was reported between 74 – 75.5% (Gebru *et al*., 2020) [4]. The amylose content of the 13 Teff varieties evaluated ranged between 20 – 26% (Akansha *et al*., 2018) [9].

Protein: Teff's protein content is 9.37% with 40.9% of average essential amino acid content (Gebru *et al*., 2020) [4] including 45%, 37%, and 12% content of glutelin, albumin, and prolamin respectively (Yilmaz & Arslan 2018) [8]. Higher concentrations of isoleucine, leucine, valine, tyrosine, threonine, methionine, phenylalanine, arginine, alanine, and histidine are found in Teff when compared with other cereals (Baye 2014) [10] and the balance between the essential amino acids is considered excellent because of the higher concentration levels of lysine (5.1-6.4%) and methionine (0.4-1%) (Satheesh & Fanta 2018) [11].

Table 1: Amino acid profile of Teff

Amino acid	Amount(g/16g N)
Lysine	3.7
Isoleucine	4.1
Leucine	8.5
Valine	5.5
Phenylalanine	5.7
Tyrosine	3.8
Threonine	4.3
Histidine	3.2
Arginine	5.2
Methionine	4.1
Cystine	2.5
Asparagine	6.4
Serine	4.1
Glutamine+ Glutamic acid	21.8
Proline	8.2
Glycine	3.1
Alanine	10.1

***Source*:** Baye, 2014 [10].

Lipids: The lipid content of Teff is 4.4% which is higher than wheat (3.6%), rice (0.9%), maize (2.5%) and sorghum (3.5%) (Yilmaz & Arslan 2018) [8]. It contains a high proportion of unsaturated fatty acids when compared with saturated fatty acids mainly linoleic acid (50%) and oleic acid (29%) (Zhu 2018) [12] including 39.9% of polyunsaturated fatty acids and 20.06% of saturated fatty acids (Satheesh & Fanta 2018) [11]. Hence, it provides a better source of fatty acids than refined flours (Baye 2014) [10].

Fibre: Teff contains crude fibre (3%,), dietary fibre (4.5%,), and soluble fibre (0.9%) which are considered higher than other cereals like maize, wheat, and sorghum (Barretto *et al*., 2021) [13]. The higher amount of fibre is accounted to the structure of the grain which is small whole grains (Baye 2014) [10] and also the higher proportion of bran which is an important source of fibre (Gebru *et al*., 2020) [4].

Micronutrients

Teff has a higher content of iron, calcium, and copper than other regular cereals which is probably due to its small size and increased contact with soil (Akansha *et al*., 2018) [9]. Teff stands out with its high bioavailability of iron content in comparison to other cereals (Assefa *et al*., 2015) [14]. In Ethiopia, where Teff is regularly consumed, there is a lower prevalence of iron-deficiency anemia, largely attributed to the nutritional benefits it offers (Nascimento *et al*., 2018) [5].

Teff also contains adequate amounts of vitamins like vitamin C, niacin, vitamin A, riboflavin, and other vitamins (Gebru *et al*., 2020) [4] but thiamine content is low in Teff when compared with other cereals (Gebremariam *et al*., 2014) [15]. In ethopia the prevalence of Fe- deficiency anaemia is lower, which is due to regular consumption of Teff (Nascimento *et al*., 2018) [5].

Phenolic compounds

Teff contains a prominent phenolic compound, ferulic acid (285.9 µg/g), emerging as a major component. Alongside, Teff has appreciable quantities of various other phenolic compounds such as protocatechuic (25.5 µg/g), gentisic (15 µg/g), vanillic (54.8 µg/g), syringic (14.9 µg/g), coumaric (36.9 µg/g), and cinnamic (46 µg/g) (Sridhara *et al*., 2021) [21].

Table 2: Nutritional composition of Teff

Macronutrients	**AMT (g/100g)**
Carbohydrates	73.1
Protein	13.3
Fat	2.38
Fiber	3.0
Micronutrients	**AMT (mg/100g)**
Thiamine (B1)	0.39
Riboflavin (B2)	0.27
Niacin (B3)	3.363
Pyridoxine (B6)	0.482
Vitamin-E	0.08
Calcium	180
Iron	7.63
Magnesium	184
Phosphorus	429
Potassium	427
Sodium	12
Zinc	3.63
Phenol Compounds	**AMT(µg/mg)**
Protocatechuic	25.5
Gentistic	15
Vanillic	54.8
Caffeic	3.9
Coumaric	36.9
Ferulic	285.9
Cinnamic	46

***Source*:** - Zhu, 2018 [12].

Health Benefits

Blood glucose lowering effect

Taking the nutritional compositions of Teff into consideration particularly, its low glycaemic index and load, essential amino acids, fatty acids, balanced vitamins and minerals, and high fibre content make it an effective food that can reduce the effects of diabetic problems (Habte *et al*., 2022) [16]. Among the macro-nutrients, the type of carbohydrates and their digestibility play a crucial role in glucose levels after consuming meals and directly on the risk to diabetes (Baye 2014) [10]. Therefore, it is anticipated that Teff-based foods would significantly contribute to the prevention and treatment of diabetes (Gebru *et al*., 2020) [4].

Role in celiac disease

Consuming a gluten-free diet promotes nutritional adequacy and prevents deficiencies (Gebremariam *et al*., 2014) [15] Compared with other gluten-free cereals, Teff is considered to be nutrient-rich grain (Baye 2014) [10] and is the best choice for celiac disease patients without any fortification (Gebru *et al*., 2020) [4].

Improvement in haemoglobin status

Patients with low haemoglobin levels are frequently affected by other diseases like malaria (Gebremariam *et al*., 2014) [15]. The consumption of 30 percent Teff-enriched wheat bread can help maintain serum iron levels in pregnant women. The high iron content of Teff helps in increasing the haemoglobin level of the blood by transmitting more oxygen and directly preventing anaemia (Gebremariam *et al*., 2014) [15].

Other health benefits

Teff contains high calcium content which helps to prevent weight gain and fat accumulation, thus helping to maintain our weight and preventing obesity. In children and adolescents, Teff helps to develop their ideal bone mass and reduce the amount of bone loss that occurs with ageing, hence preventing osteoporosis (Gebremariam *et al*., 2014) [15].

Value added products

Bakery products: Coleman 2013 developed bread, cakes, cookies, and biscuits by replacing wheat flour with 10%. 20%, 30%, 40%, and 100% to evaluate the quality of baked products and concluded that it is possible to bake cake and bread with lower percentages of Teff, but the quality of the final product was impaired at higher percentages (40 and 100%) of Teff flour. Cookies were more promising with 20% and 40% Teff flour as they didn't require gluten formation but were found to be softer and grainy. No baked products produced are acceptable by using 100% Teff flour but a combination of Teff flour with other gluten free flours can be acceptable while still maintaining the benefits of Teff's flour.

Fig 2: Teff cookies

Pasta

Hager 2012 [18] developed a gluten-free fresh egg pasta based on wheat, oat, and Teff flour combining egg white powder to aid the structure formation and evaluated the textural properties of the three pastas produced and observed the firmness of pasta were similar in three pastas but the force at rupture was highest in the wheat pasta indicating that other kinds of pasta made of oat and Teff are less elastic. When the stickiness is compared between the wheat and oat pasta showed the same range but the Teff pasta showed significantly less stickiness and hence this study clearly showed that the formation of pastas from gluten-free flours like oat and Teff is texturally acceptable.

Fig 3: Teff Pasta

Sausages

Kerimoglu *et al*. 2020 study showcased the effectiveness of using quinoa flour (QF) or Teff flour (TF) as partial substitutes for beef fat in emulsion sausages. The incorporation of 5% QF (Q), 5% TF (T), and a combination of 2.5% QF and 2.5% TF (QT) resulted in improved water holding capacity and heightened emulsion stability compared to the control group (C) with 20% beef fat. These alternative formulations led to increased moisture and carbohydrate levels, alongside reduced fat content and energy values. Notably, Teff flour caused noticeable shifts in color and texture. Overall, both QF and TF enable significant fat reduction by over 50%, offering a pathway to craft healthier emulsified sausages with enhanced nutritional profiles.

Fig 4: Teff Sausages

Injero

Abera *et al*. 2016 utilized D-optimal mixture design to formulate Teff-taro blended flour for Injera preparation.

Through sensory quality evaluation and proximate composition analysis, it was found that increasing taro content negatively impacted sensory acceptance. However, the composite flour Injera's moisture, protein, crude fiber, fat, and carbohydrate contents remained statistically consistent across varying mixing ratios. Notably, ash content demonstrated a significant difference, highlighting taro's influence. The optimal blend ratio of 85% Teff and 15% taro emerged as the preferred choice, delivering high-quality Injera in terms of sensory attributes and nutritional composition, surpassing other combinations in both aspects.

Fig 5: Teff Injero

Bread

Ziec *et al*. 2021 research investigated the influence of Teff flour on wheat bread's technological process and quality. Teff flour, analyzed for its chemical composition, emerged as a valuable enhancer for wheat bread. The study encompassed three formulations, incorporating 5%, 10%, and 15% Teff flour into the standard bread mixture. Incorporating Teff flour led to reduced gluten content, springiness, and extensibility in the dough, especially notable at 10% and 15% levels, as supported by alveograph studies. Employing 20% Teff flour and sourdough prepared with lactic acid bacteria "Biolight" improved structural and mechanical parameters. This enhancement yielded a 4.0% increase in specific volume and 2.9% increase in acidity, accompanied by a distinct "nutty" taste and aroma. Consumption of 10% Teff-enriched bread substantially met nutritional needs, including protein (42.9-49.8%), iron (32.3-28.5%), vitamin B5 (17.6-24.2%), and phosphorus (26.7%) for both genders. The resultant technology presents a robust method for crafting high-quality, nutritionally rich wheat bread with Teff, suitable for wide-scale industrial implementation.

Fig 6: Teff Bread

Muffins

Minarovicova *et al*, (2019) [22] explored the impact of incorporating Teff flour (25%, 50%, and 75%) into rice muffins, assessing both qualitative and sensory attributes. Up to 50% Teff flour addition yielded favorable results, enhancing antioxidant activity and maintaining desirable texture. However, higher Teff flour levels (75%) adversely affected muffin qualities, leading to increased hardness, crumbliness, and reduced springiness. The intrinsic antioxidant potential of Teff translated into heightened antioxidant activity in the baked products. Enriched muffins exhibited a delightful flavour with a sweet and nutty undertone. Sensory assessment indicated that rice muffins with 25% Teff flour were the most well-received among evaluators. This study underscores the feasibility of incorporating Teff flour to enhance both the nutritional and sensory attributes of rice muffins.

Fig 7: Teff Muffins

Conclusion

Teff, a versatile gluten-free cereal, offers a wealth of nutritional benefits and culinary applications. Its iron content and bioavailability address anemia concerns, while essential amino acids, fatty acids, vitamins, and minerals support overall health. Teff's low glycemic index is promising for diabetes management. Its phenolic compounds, including ferulic acid, bring antioxidant properties. Teff proves advantageous for celiac patients and provides a sustainable food source.

Teff's integration into bakery goods, pasta, and sausages underscores its adaptability. While challenges exist at higher substitution levels, Teff-enriched products introduce unique textures and flavors. Its adaptability to diverse climates positions it as a tool for mitigating malnutrition and enhancing food security. Teff's role in bone health, animal feed, and construction material amplifies its significance.

Teff's potential to tackle nutritional challenges, foster sustainability, and improve public health is evident. Ongoing research and innovation will further drive its incorporation into diets and food systems, promising positive impacts on global well-being.

References

1. Viell FLG, Madeira TB, Nixdorf SL, Gomes STM, Bona E, Matsushita M. Comparison between ultra-homogenisation and ultrasound for extraction of phenolic compounds from Teff (*Eragrostis tef* (Zucc.)). International Journal of Food Science & Technology. 2020;55(7):2700-2709.
2. El-Alfy TS, Ezzat SM, Sleem AA. Chemical and biological study of the seeds of *Eragrostis tef* (Zucc.)

Trotter. Natural Product Research. 2012;26(7):619-629.
3. Andreotti F, Bazile D, Biaggi C, Callo-Concha D, Jacquet J, Jemal OM, *et al*. When neglected species gain global interest: Lessons learned from quinoa's boom and bust for Teff and minor millet. Global Food Security. 2022;32:100613.
4. Gebru YA, Sbhatu DB, Kim KP. Nutritional composition and health benefits of Teff (*Eragrostis tef* (Zucc.) Trotter). Journal of Food Quality; c2020. p. 1-6.
5. Do Nascimento KDO, Paes SDND, de Oliveira IR, Reis IP, Augusta IM. Teff: Suitability for different food applications and as a raw material of gluten-free, a literature review. Journal of Food and Nutrition Research. 2018;6:74-81.
6. Tadele E, Hibistu T. Spatial production distribution, economic viability and value chain features of Teff in Ethiopia: Systematic review. Cogent Economics & Finance. 2022;10(1):2020484.
7. Minten B, Tamru S, Engida E, Kuma T. Transforming staple food value chains in Africa: The case of Teff in Ethiopia. The Journal of Development Studies. 2016;52(5):627-645.
8. Yilmaz HO, Arslan M. Teff: nutritional compounds and effects on human health. Acta Scientific Medical Sciences. 2018;2(9):15-18.
9. Akansha KS, Chauhan ES. Nutritional composition, physical characteristics and health benefits of Teff grain for human consumption: A. Critical review. The Pharma Innovation Journal. 2018;7(10):03-07.
10. Baye K. Teff: nutrient composition and health benefits. International Food Policy Research Instant; c2014. 67.
11. Satheesh N, Fanta SW. Review on structural, nutritional and anti-nutritional composition of Teff (*Eragrostis tef*) in comparison with Quinoa (*Chenopodium quinoa* Willd.). Cogent Food & Agriculture. 2018;4(1):1546942.
12. Zhu F. Chemical composition and food uses of Teff (*Eragrostis tef*). Food chemistry. 2018;239:402-415.
13. Barretto R, Buenavista RM, Rivera JL, Wang S, Prasad PV, Siliveru K. Teff (*Eragrostis tef*) processing, utilization and future opportunities: a review. International Journal of Food Science & Technology. 2021;56(7):3125-3137.
14. Assefa K, Cannarozzi G, Girma D, Kamies R, Chanyalew S, Plaza-Wüthrich S, *et al*. Genetic diversity in tef [*Eragrostis tef* (Zucc.) Trotter]. Frontiers in plant science. 2015;6:177
15. Gebremariam MM, Zarnkow M, Becker T. Teff (*Eragrostis tef*) as a raw material for malting, brewing and manufacturing of gluten-free foods and beverages: a review. Journal of food science and technology. 2014;51:2881-2895.
16. Habte ML, Beyene EA, Feyisa TO, Admasu FT, Tilahun A, Diribsa GC. Nutritional Values of Teff (*Eragrostis tef*) in Diabetic Patients: Narrative Review. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy; c2022. p. 2599-2606.
17. Coleman J, Abaye AO, Barbeau W, Thomason W. The suitability of Teff flour in bread, layer cakes, cookies and biscuits. International Journal of Food Sciences and Nutrition. 2013;64(7):877-881.
18. Hager AS, Lauck F, Zannini E, Arendt EK. Development of gluten-free fresh egg pasta based on oat and Teff flour. European Food Research and Technology. 2012;235:861-871.
19. Öztürk-Kerimoğlu B, Kavuşan HS, Tabak D, Serdaroğlu M. Formulating reduced-fat sausages with quinoa or Teff flours: effects on emulsion characteristics and product quality. Food Science of Animal Resources. 2020;40(5):710.
20. Abera A, Milkesa M, Gebremedhin H. Injera preparation from taro (*Colocasia esculenta*) and Teff (*Eragrostis tef*) flour. International Journal of Sciences; Basic and Applied Research. 2016;30(1):196-204.
21. Zięć G, Gambuś H, Lukasiewicz M, Gambuś F. Wheat bread fortification: the supplement of Teff flour and chia seeds. Applied Sciences. 2021;11(11):5238.
22. Minarovičová L, Lauková M, Karovičová J, Kohajdová Z, Kepičová V. Gluten-free rice muffins enriched with Teff flour. Potravinarstvo, 2019, 13(1).
23. Sridhara S, Punith Gowda HN, Manoj KN, Gopakkali P. Nutritional importance of Teff (*Eragrostis tef* (Zucc.) Trotter) and human health: a critical review. International Scholars Journal, 2021, 11(2).