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Research Article

TEFF (*Eragrostis tef*) AS AN ALTERNATIVE GRAIN IN TRADITIONAL TURKISH CUISINE: REFORMULATION AND NUTRITIONAL EVALUATION FOR GLUTEN-FREE DEVELOPMENT**

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Abstract

The aim of this study was to evaluate the applicability of teff (*Eragrostis tef*), a naturally gluten-free grain, as an alternative to wheat-based ingredients in dishes commonly consumed in traditional Turkish cuisine. The study was designed as descriptive research, and a literature review was conducted together with practical culinary applications. Within the scope of the study, teff was used in flour, whole grain, and fermented forms to develop recipes representing soup, main course, salad, pastry, and dessert groups; accordingly, tarhana soup, fellah meatballs, kısır, akıtma (crepe), and nevzine dessert were prepared. The nutritional composition of the developed recipes was calculated using The Nutrition Information System (BEBİS) program. The findings indicate that teff can be successfully adapted to different food groups while preserving the traditional structure of the recipes. The calculated nutrient values suggest a favorable contribution of teff to dietary fiber and mineral content, particularly in terms of iron, calcium, magnesium, and phosphorus. In conclusion, teff may contribute to the diversification of gluten-free products and to the expansion of alternative grain use in traditional Turkish cuisine.

Keywords: Teff, Gluten-Free Nutrition, Functional Grains, Turkish Cuisine, Recipe Development

Introduction

Gluten-free diets have become increasingly prevalent in the general population due to both medical necessities, such as celiac disease and gluten intolerance, and the growing influence of health-conscious lifestyle and dietary trends (Saturni, Ferretti, Bacchetti, 2010; Melini and Melini, 2019; Fry, Madden, Fallaize, 2018). However, gluten-free dietary patterns are often characterized by a limited diversity of cereal sources, which may be associated with inadequate intake of certain micronutrients, particularly iron, calcium, magnesium, and folate (Baye, 2014; Allen and Orfila, 2018; Melini and Melini, 2019). Therefore, gluten-free diets are increasingly expected not only to eliminate gluten-containing grains but also to be supported by nutritionally rich alternative ingredients (Saturni et al., 2010; Thompson et al., 2005). Cereal-based traditional foods constitute a fundamental component of daily nutrition in many culinary cultures and are widely consumed in various product categories, including soups, baked goods, meat-based dishes, and salads (Bultosa, 2007). In the development of gluten-free alternatives to such traditional products, it is important to consider not only sensory acceptability but also nutritional quality (Alaunyte et al., 2012; Gallagher et al., 2004). In this context, the reformulation of traditional foods using nutrient-dense grains may represent an effective approach to enhancing both dietary diversity and nutritional adequacy within gluten-free diets (Zhu, 2018; Melini and Melini, 2019).

Teff (*Eragrostis tef*), a naturally gluten-free grain recognized for its notable nutritional composition, has emerged as a promising alternative raw material within this framework (Spaenij-Dekking, Kooy-Winkelaar, Koning, 2005; Baye, 2014; Gebremariam, Zarnkow, Becker 2014). Despite its nutritional potential, the use of teff in Turkish cuisine remains limited, and studies focusing on its adaptation to traditional Turkish recipes

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are relatively scarce (Özköse, Acar, Kamacı, 2022). This gap highlights an opportunity for further research aimed at exploring the gastronomic potential of teff and evaluating its applicability across different product groups.

Accordingly, the aim of this study is to develop teff-based recipes adapted to various product categories within Turkish cuisine and to evaluate their nutritional composition. By examining the use of teff in traditional formulations, this study seeks to assess its potential contribution to gluten-free dietary practices and to the diversification of cereal-based products.

Literature Review

General Characteristics of Teff (Eragrostis tef)

Teff (Eragrostis tef) is a cereal crop belonging to the Poaceae family and is naturally gluten-free. It originates from East Africa, particularly Ethiopia, where it has been consumed as a staple food for thousands of years. Due to its long history of cultivation and consumption, teff is regarded as one of the oldest domesticated cereal crops in the world and constitutes an integral component of traditional Ethiopian food culture (D'Andrea, 2008; Minten et al., 2013).

Teff is distinguished from other cereal grains by its extremely small kernel size and its predominant use in whole-grain form. The minute size of the grains limits the separation of bran and germ fractions during processing, which contributes to the retention of nutrients and bioactive compounds (Bultosa, 2002). The high proportion of whole-grain consumption is therefore considered one of the primary reasons why teff is recognized as a nutritionally valuable cereal (Satheesh and Fanta, 2018).
The teff plant is characterized by short and slender stems and is described as a resilient species capable of adapting to diverse agroecological conditions. Its tolerance to drought, short growing season, and low input requirements allow teff to be considered a reliable cereal alternative in semi-arid regions (Ketema, 1997; Assefa et al., 2011). In recent years, due to its natural lack of gluten and nutrient-dense composition, teff has been increasingly regarded as an important alternative for individuals with celiac disease as well as for those adhering to gluten-free dietary patterns. Previous studies have demonstrated that teff proteins do not exhibit toxic effects in individuals with celiac disease and can be safely incorporated into gluten-free diets (Spaenij-Dekking et al., 2005). Accordingly, teff has gained attention not only within the context of medical nutrition therapy but also among the broader consumer population, in parallel with the growing popularity of gluten-free diets (Saturni et al., 2010; Zhu, 2018).

Teff is commonly classified into white and red brown varieties based on grain color. White teff is generally preferred due to its milder flavor profile, whereas red teff is characterized by a darker color and more pronounced aroma. The literature reports that red teff varieties tend to be richer in iron and phenolic compounds, which may be associated with a higher antioxidant potential (Baye, 2014; Shumoy and Raes, 2017). Owing to these attributes, teff emerges as a versatile cereal with potential applications not only in traditional cuisines but also in modern food systems and contemporary gastronomic practices.

Nutritional Value and Functional Properties of Teff

Teff (Eragrostis tef) is regarded as a cereal of increasing interest in the fields of nutrition science and food studies due to its balanced composition of macro and micronutrients (Baye, 2014). The primary components of teff grains include carbohydrates, protein, dietary fiber, and lipids, and the overall macronutrient distribution has been reported to be comparable to that of commonly consumed cereals (Bultosa, 2007; Mengesha, 1966).

Although the protein content of teff is reported to be similar to that of cereals such as wheat and oats, its lack of gluten places teff protein in a distinct nutritional context (Spaenij-Dekking et al., 2005; Zhu, 2018). Studies examining the amino acid profile of teff proteins have indicated a relatively higher lysine content compared to many other cereals, which may positively influence protein quality (Baye, 2014; Abebe et al., 2007).
From a mineral composition perspective, teff is particularly notable for its calcium, iron, and magnesium content. Several studies have demonstrated that the calcium content of teff is markedly higher than that of cereals such as wheat, barley, and rice (Mengesha, 1966; Baye, 2014). This characteristic has been associated with the potential contribution of teff to bone health and overall mineral intake (Amare, Mouquet-Rivier, Picq, 2015; Abebe et al., 2007).
With respect to iron content, teff has been highlighted as a cereal of interest, particularly in populations where iron deficiency is prevalent. The literature indicates that while the total iron content of teff is relatively high, its bioavailability may be influenced by antinutritional factors such as phytates (Baye et al., 2014; Cercamondi

et al., 2017). However, traditional processing methods, including fermentation, have been reported to reduce phytate levels and thereby enhance iron bioavailability (Shumoy et al., 2016).
Teff also exhibits considerable potential in terms of dietary fiber content. The presence of both soluble and insoluble fiber fractions is regarded as beneficial for supporting digestive health and modulating glycemic response (Satheesh and Fanta, 2018; Melini and Melini, 2019). Accordingly, teff consumption has been discussed within the context of low glycemic index dietary patterns (Bultosa, 2007; Zhu, 2018).
Beyond its macronutrient and mineral composition, the functional properties of teff are also associated with its content of phenolic compounds and flavonoids, which have been linked to antioxidant activity. These bioactive components have been reported to occur at higher levels in darker-colored teff varieties, suggesting potential variability in antioxidant capacity among different teff types (Shumoy and Raes, 2016).
In terms of vitamin composition, teff is notable for its folate content and the presence of several B-group vitamins. Folate intake is considered particularly important in cereal-based dietary patterns, and teff may provide a meaningful contribution in this regard (Melini and Melini, 2019). Given the role of folate in cell division and hematopoietic processes, this characteristic further supports the nutritional relevance of teff (Baye, 2014).

Within this context, the comparative nutritional composition of teff and commonly consumed cereals, including wheat, barley, oats, and rice, is presented in Table 1. The table was prepared based on data directly retrieved from the USDA Food Data Central (SR Legacy) database and aims to illustrate the relative macro- and micronutrient characteristics of teff.

Table 1. Nutritional Composition of Teff And Selected Commonly Consumed Cereals (per 100 g, raw, grain basis)

Nutrient	Teff	Wheat	Barley	Oats	Rice
Energy (kcal)	367	340	352	380	365
Protein (g)	13.3	15.1	9.9	17.3	7.1
Carbohydrate (g)	73.1	72.0	77.7	66.2	80.0
Total fat (g)	2.4	2.7	1.2	6.9	0.7
Dietary fiber (g)	8.0	11	15.6	10.6	1.3
Vitamins					
Thiamin (Vitamin B1, mg)	0.39	0.50	0.19	1.10	0.07
Riboflavin (Vitamin B2, mg)	0.27	0.12	0.11	0.20	0.05
Vitamin B6 (mg)	0.48	0.30	0.20	0.10	0.10
Folate (µg)	87	39	23	56	8.0
Minerals					
Calcium (mg)	180	38	29	54	28
Iron (mg)	7.6	3.8	2.5	4.7	1.5
Magnesium (mg)	184	136	79	177	116
Zinc (mg)	3.6	3.2	2.1	3.1	2.1
Phosphorus (mg)	429	352	221	523	311

Source: USDA Food Data Central (2026)

According to the data presented in Table 1, the protein content of teff (13.3 g/100 g) is slightly lower than that of wheat (15.1 g/100 g) and oats (17.3 g/100 g), but higher than that of barley (9.9 g/100 g) and rice (7.1 g/100 g). Although teff contains protein in amounts comparable to several commonly consumed cereals, its gluten-free nature constitutes an important distinguishing feature, as emphasized in the literature (Bultosa, 2007; Zhu, 2018).

With respect to mineral composition, teff appears particularly prominent in terms of calcium content. The calcium level of teff (180 mg/100 g) is substantially higher than that of wheat (38 mg/100 g), barley (29 mg/100 g), oats (54 mg/100 g), and rice (28 mg/100 g). This relatively high calcium content has been consistently reported in previous studies and is considered nutritionally relevant, particularly in relation to bone health (Baye, 2014; Abebe et al., 2007). Similarly, the iron content of teff (7.6 mg/100 g) exceeds that of wheat (3.8 mg/100 g), barley (2.5 mg/100 g), oats (4.7 mg/100 g), and rice (1.5 mg/100 g). In this regard, the literature suggests that teff may represent a valuable cereal alternative in dietary patterns addressing iron deficiency, especially among populations at risk (Baye, 2014; Melini and Melini, 2019).

Magnesium levels were also found to be relatively high in teff (184 mg/100 g) compared with wheat (136 mg/100 g), barley (79 mg/100 g), and rice (116 mg/100 g), although oats exhibited a comparable magnesium content (177 mg/100 g). These findings align with previous reports describing teff as a mineral-rich cereal grain (Zhu, 2018).

In terms of vitamin composition, teff provides 87 µg/100 g of folate, a value notably higher than that of rice (8 µg/100 g) and barley (23 µg/100 g), and also exceeding that of wheat (39 µg/100 g) and oats (56 µg/100 g). The literature highlights teff as a nutrient-dense cereal particularly rich in certain B-group vitamins, including folate, which is nutritionally significant during periods of growth and development (Baye, 2014).

Taken together, the numerical data presented in Table 1 and the findings reported in the literature suggest that teff possesses a distinctive nutritional profile characterized by high calcium and iron content and moderate protein levels, while remaining naturally gluten-free. These attributes indicate that teff may offer noteworthy nutritional potential as an alternative cereal in the development of gluten-free products traditionally based on wheat, barley, oats, or rice (Bultosa, 2007; Baye, 2014; Zhu, 2018).

Use of Teff in Gastronomy and the Food Industry

Teff (*Eragrostis tef*), beyond its traditional uses, has increasingly been recognized as a cereal evaluated within the context of healthy and alternative dietary approaches in contemporary gastronomy and the food industry (Gebremariam et al., 2014). The global rise in gluten-free dietary patterns has emerged as one of the key factors supporting the expanded use of teff in food production systems (Arendt and Dal Bello, 2008).

In the food industry, teff flour has been utilized primarily in gluten-free bakery products, including bread, cakes, cookies, biscuits, and crackers. Previous studies have indicated that the incorporation of teff flour may enhance the nutritional value of such products; however, quality attributes such as volume and texture appear to be sensitive to formulation composition and processing conditions (Alaunyte et al., 2012). For this reason, teff is often formulated in combination with other gluten-free flours or hydrocolloids to improve technological performance (Gallagher, Gormley, Arendt, 2004).

Sensory acceptability of teff-based gluten-free products may vary depending on grain color, degree of milling, and the use of auxiliary ingredients. It has been reported that white teff flour allows for the development of lighter-colored products with a more neutral flavor profile, whereas brown teff tends to impart a more pronounced aroma (Ronda et al., 2017). Industrial-scale studies have further suggested that the starch structure and water-holding capacity of teff flour play a determining role in dough rheology. These characteristics may contribute to its structure formation, particularly in gluten-free systems (Hager et al., 2012; Mancebo, Picón, Gómez, 2015). Nevertheless, the literature emphasizes that careful control of processing parameters is required to achieve optimal product quality in teff-containing formulations (Campo et al., 2016).

In recent years, teff has been incorporated not only into bakery products but also into breakfast cereals, energy bars, and products designed for sports nutrition. In such applications, teff has been discussed as a potential contributor in terms of complex carbohydrate content and micronutrient composition (Brouns, Van Buul, Shewry, 2013; Melini and Melini, 2019). In addition, the growing interest in plant-based dietary patterns has facilitated the broader integration of teff into modern gastronomic practices. Fermentation and sourdough applications represent important approaches for improving aroma development and textural properties in teff-based products. Studies have indicated that fermentation processes involving teff may positively influence product quality. Within this framework, teff is considered a technically adaptable raw material suitable for both traditional and innovative gastronomic applications (Zhu, 2018; Shumoy et al., 2019).

Use of Teff in Traditional Cuisines

Teff (*Eragrostis tef*) has historically been widely consumed in the Horn of Africa and is regarded as one of the principal cereal sources in Ethiopian and Eritrean cuisines. In these regions, teff is not only a component of daily dietary practices but is also considered a traditional food ingredient closely integrated with agricultural production systems, culinary culture, and social identity (Gebremariam et al., 2014; D'Andrea, 2008). Archaeobotanical and ethnographic evidence suggests that teff has evolved in parallel with local culinary practices over an extended historical period, serving as an important indicator of cultural continuity (Cochrane, 2022).

The most well-known traditional application of teff is in the production of injera, a fermented flatbread. Injera is prepared by mixing teff flour with water, allowing the mixture to undergo natural fermentation, and subsequently baking it on a griddle-like surface, resulting in a product with a spongy texture and mildly sour flavor. Previous studies have reported that the fermentation process influences not only the sensory characteristics of injera but also its microbial profile and digestibility (Yetneberk, Rooney, Taylor, 2005; Ashenafi and Mehari,1995). Beyond fermented bread, teff is also utilized in various other traditional food products within Ethiopian cuisine. *Genfo* is a porridge-like dish prepared by cooking teff flour with water,

while *atmit* is produced by roasting teff flour and mixing it with water or milk; this beverage-like preparation is often preferred for children, older adults, and individuals requiring nutrient-dense foods. These traditional products illustrate the versatility of teff and its ability to adapt to different cooking techniques and consumption forms (Abegaz, 2013; Tafere, 2015).

Outside the Horn of Africa, teff is not traditionally native to local cuisines; however, migration patterns and cultural exchanges have facilitated its introduction into other regions. In particular, the dissemination of teff-based traditional foods most notably injera has been reported in North America and Europe through Ethiopian and Eritrean diaspora communities, primarily via ethnic restaurants and local markets (Gebremariam et al., 2014; Ray, 2016; Long, 2015). In recent years, teff has been increasingly reconsidered within the framework of "ancient grains" and has attracted attention as an alternative ingredient in traditional cereal-based foods across diverse culinary cultures. The incorporation of teff into products such as soups, porridges, meatballs, and dough-based foods suggests that this grain may be adapted to different culinary traditions without losing its cultural origins (Zhu, 2018). Within this context, examples of teff use in traditional cuisines provide an important conceptual foundation that may inspire contemporary gastronomic applications.

Methods

This study was designed as a descriptive and application-based investigation aiming to evaluate the use of teff (Eragrostis tef), a nutrient dense cereal suitable for gluten-free diets, as a grain component in selected traditional Turkish foods. The research process was conducted in two main phases: a literature review and a gastronomic application phase.

In the first phase, national and international literature addressing the nutritional composition of teff, its role in gluten-free nutrition, and its applications in food systems was reviewed. Particular attention was given to studies highlighting its dietary fiber content and selected micronutrients, including iron, calcium, magnesium, and phosphorus. Nutrient composition values presented in Table 1 were directly retrieved from the USDA FoodData Central (SR Legacy) database to ensure international data standardization.

In the second phase, representative foods commonly consumed in Turkish cuisine and covering different product categories namely soup, main dish, salad, dessert, and dough based products were selected as sample products. The selection of these dishes was based on their widespread consumption and their reliance on cereal-based ingredients such as wheat flour or bulgur, which constitute the primary grain sources in Turkish dietary patterns. Considering the central role of wheat in Turkish cuisine, these dishes were regarded as suitable models for evaluating the substitution of wheat based components with teff as a gluten-free alternative.

Traditional recipes were used as the foundation for each product. The recipes were adapted and standardized by the researcher based on traditional preparation practices documented in Turkish culinary literature. Preparation techniques, ingredient composition, and portion structure were preserved. Within the scope of the study, only the cereal components present in the traditional formulations, such as wheat flour or bulgur (parboiled cracked wheat), were replaced with teff. All other ingredients and preparation steps were kept constant in order to maintain the structural and culinary identity of the original dishes.

Within the scope of this study, the tarhana used for the preparation of tarhana soup was produced by the researcher following a traditional fermentation process. In this formulation, teff was incorporated as the cereal component instead of wheat flour typically included in conventional tarhana production.

All recipes developed in this study were planned on a single-portion basis. The quantities of raw materials were determined to represent the amount typically consumed by an individual in a single meal. Solid ingredients were standardized using gram (g) measurements, while liquid ingredients were measured in milliliters (mL) using precise weighing and measuring techniques. All ingredients and quantities used in the teff-based recipes were recorded to serve as the basis for nutritional calculations. Each recipe was prepared by the researcher following standardized procedures, and the final products were documented through photography under controlled conditions.

The energy and nutrient composition of the products was calculated using The Nutrition Information System (BEBİS) software, based on the pre-cooking net weights of the raw ingredients used in the recipes. Calculations included energy, macronutrients, and selected micronutrients using nutrient composition values per 100 g provided in the program's database. The obtained data were evaluated descriptively to characterize the nutritional properties of the teff-based recipes, and no statistical analysis was applied. *Since secondary data were used in this study, ethical permission is not required.*

Findings

In this section, the energy and nutrient composition values calculated on a single-portion basis for the teff-based recipes developed within the scope of the study are presented. The obtained findings were evaluated descriptively in line with data reported in the relevant literature. Nutrient composition calculations for the recipes were performed using the The Nutrition Information System (BEBİS) software, and the numerical results are presented in tables. In the accompanying text, portion-based comparative evaluations are provided to support the interpretation of the findings.

Table 2. Standard Recipe and Nutrient Composition per Serving of Teff Tarhana

Dish Name: Teff Tarhana
Number of Servings: 1
Serving Size (g/ml): 50 g
Preparation Technique: Fermentation, drying

Ingredients	Amount	Weight (g)	Preparation Method
Red pepper	5	g	Pepper is deseeded and coarsely chopped.
Tomato	5	g	Tomato is washed and coarsely chopped.
Onion	5	g	Onion is washed, peeled, and coarsely chopped
Strained yoğurt	8	g	Vegetables are blended into a purée and mixed with yogurt.
Red chili flakes	0,5	g	Chili flakes are added to the mixture.
Dried mint	0,5	g	Dried mint is added to the mixture
Salt	1	g	Salt is added to the mixture.
Teff flour	25	g	Teff flour is added and kneaded. The dough is left to ferment at room temperature for 3 days. After fermentation, the dough is dried in a thin layer. Once fully dried, it is ground into flour using a food processor.
Nutrients Compositions (per serving)			
Energy (kcal): 107.4	Protein (g**):** 4.4	Carbohydrate (g): 20.2	Fat (g): 1.2 Dietary Fiber (g): 2.6
Calcium (mg): 60.7	Iron (mg): 2.2	Magnesium (mg): 50	Phosphorus (mg): 122.7

Note: Recipes were developed, prepared, and documented by the researcher

According to the data presented in Table 2, one serving (50 g) of teff tarhana provides 107.4 kcal of energy. The product contains 4.4 g protein, 20.2 g carbohydrates, 1.2 g fat, and 2.6 g dietary fiber per serving. The mineral composition per serving includes calcium (60.7 mg), iron (2.2 mg), magnesium (50 mg), and phosphorus (122.7 mg).

Table 3. Standard Recipe and Nutrient Composition per Serving of Teff Tarhana Soup

Dish Name: Teff Tarhana Soup
Number of Servings: 1
Serving Size (g/ml): 250 mL
Preparation Technique**:** Boiling

Ingredients	Amount	Weight (g/ml)	Preparation Method
Butter	10	g	Butter is added to the pot and melted.
Tomato paste	5	g	Tomato paste is added and sautéed
Teff tarhana	25	g	Teff tarhana is added and sautéed briefly
Water	250	ml	Water is added and the mixture is brought to a boil.
Salt	1	g	Salt is added and the soup is boiled for 5 minutes
Nutrients Compositions (per serving)			
Energy (kcal): 129.5	Protein (g): 2.5	Carbohydrate (g): 11.1	Fat (g): 8.7 Dietary Fiber (g): 1.5
Calcium (mg**)**: 34.8	Iron (mg): 1.3	Magnesium (mg): 27.3	Phosphorus (mg): 67.9

Note: Recipes were developed, prepared, and documented by the researcher

According to the data presented in Table 3, one serving (250 g) of teff tarhana provides 129.5 kcal of energy. The product contains 2.5 g protein, 11.1 g carbohydrates, 8.7 g fat, and 1.5 g dietary fiber per serving. The mineral composition per serving includes calcium (34.8 mg), iron (1.3 mg), magnesium (27.3 mg), and phosphorus (67.9 mg).

Table 4. Standard Recipe and Nutrient Composition per Serving of Fellah Köftesi

Dish Name: Fellah Köftesi
Number of Servings: 1
Serving Size (g/ml): 200 g
Preparation Technique: Boiling

Ingredients	Amount	Weight (g)	Preparation Method
Onion	20	g	The onion is washed, peeled, and grated.
Tomato paste	10	g	Tomato paste is added.
Pepper paste	10	g	Pepper paste is added.
Cumin	2	g	Cumin is added.
Black pepper	1	g	Black pepper is added.
Dried mint	1	g	Dried mint is added.
Salt	1	g	Salt is added.
Teff seeds	25	g	Teff grains are first boiled for 10 minutes. The cooked teff is then added to the mixture.
Teff flour	25	g	Teff flour is added. All ingredients are kneaded for approximately 5 minutes. Small balls are formed from the mixture, and a small indentation is made in the center of each ball using a fingertip.
Water	1	L	Water is brought to a boil and salt is added. The prepared dumplings are added to the boiling water and

			cooked for 5 minutes. The cooked dumplings are drained.
Olive oil	20	ml	Olive oil is added to a pan.
Tomato paste	10	g	Tomato paste is added and sautéed
Tomato	30	g	Tomatoes are grated, added to the sautéed paste, and cooked.
Garlic	2	g	Garlic is grated, added to the tomato sauce, and sautéed.
Salt	1	g	Salt is added and the tomato sauce is simmered for 5 minutes. The boiled dumplings are drained, added to the sauce, mixed, and cooked for an additional 1 minute.
Yogurt	40	g	Yogurt is placed on a serving plate, and the dumplings are placed on top.
Parsley	1	g	Parsley is finely chopped and sprinkled over the dumplings
Nutrients Compositions (per serving)			
Energy (kcal): 408.5	Protein (g): 10.3	Carbohydrate (g): 48.5	Fat (g): 20.6	Dietary Fiber (g): 6.5
Calcium (mg): 191.2	Iron (mg): 6.7	Magnesium (mg): 125.3		Phosphorus (mg): 302.1

Note: Recipes were developed, prepared, and documented by the researcher

According to the data presented in Table 4, the energy content of one serving (200 g) of fellah köftesi prepared using teff grain and teff flour is 408.5 kcal. The product contains 10.3 g protein, 48.5 g carbohydrates, 20.6 g fat, and 6.5 g dietary fiber per serving. The calcium (191.2 mg), iron (6.7 mg), magnesium (125.3 mg), and phosphorus (302.1 mg) contents of one serving were calculated accordingly.

Table 5. Standard Recipe and Nutrient Composition per Serving of Teff Kısır

Dish Name: Teff Kısır
Number of Servings: 1
Serving Size (g/ml): 200 g
Preparation Technique: Boiling

Ingredients	Amount	Weight (g/ml)	Preparation Method
Water	250	ml	Water is placed in a pot.
Teff seeds	50	g	Teff is added to boiling water, boiled for 15 minutes, and then drained.
Olive oil	30	g	Olive oil is added to a pan.
Onion	25	g	Onion is washed, peeled, finely chopped, and sautéed in olive oil for 2 minutes.
Pepper paste	20	g	Pepper paste is added and sautéed with the onion. The boiled teff is added and sautéed together.
Cumin	1	g	Cumin is added to the mixture
Red chili flakes	1	g	Red chili flakes are added.
Black pepper	1	g	Black pepper is added.
Parsley	12	g	Parsley is washed and finely chopped.
Fresh mint	10	g	Fresh mint is washed and finely chopped.
Lettuce	10	g	Lettuce is washed and finely chopped.
Pomegranate	20	g	Pomegranate arils are added.
Lemon	10	g	Lemon juice is squeezed and added
Pomegranate molasses	10	g	All ingredients are mixed, and pomegranate molasses is drizzled on top.
Nutrients Compositions (per serving			

Energy (kcal): 432.8	Protein (g): 6.6	Fat (g): 31.2	Carbohydrate (g): 35.9	Dietary Fiber (g): 7.1
Calcium (mg): 109.4	Iron (mg): 4.2		Magnesium (mg): 88.6	Phosphorus (mg): 228.5

Note: Recipes were developed, prepared, and documented by the researcher

According to the data presented in Table 5, the energy content of one serving (200 g) of teff kısır prepared using 50 g raw teff grain is 432.8 kcal. The product contains 6.6 g protein, 35.9 g carbohydrates, 31.2 g fat, and 7.1 g dietary fiber per serving. The mineral composition per serving includes calcium (109.4 mg), iron (4.2 mg), magnesium (88.6 mg), and phosphorus (228.5 mg)

Table 6. Standard Recipe and Nutrient Composition per Serving of Nevzine Dessert

Dish Name: Nevzine Dessert
Number of Servings: 1
Serving Size (g/ml): 125 g
Preparation Technique: Baking

Ingredients	Amount	Weight (g/ml)	Preparation Method
Butter	5	g	Softened butter is placed in a bowl.
Tahini	8	g	Tahini is added to the bowl.
Yogurt	5	g	Yogurt is added, and all ingredients are mixed thoroughly.
Teff flour	40	g	Teff flour is added to the mixture.
Baking powder	0,5	g	Baking powder is added to the mixture
Vanillin	0,5	g	Vanilla is added. The mixture is kneaded until a dough forms.
Ground walnuts	5	g	Walnuts are added to the dough and kneaded. The dough is spread on a baking tray to a thickness of approximately 1 cm and baked at 175°C for 30 minutes.
For syrup			
Water	30	ml	Water is placed in a saucepan
Granulated sugar	15	g	Sugar is added to the saucepan.
Fresh lemon juice	1	g	Lemon juice is added, and the syrup is boiled for 2 minutes.
Grape molasses	15	g	The heat is turned off, grape molasses is added, and the syrup is mixed. The warm syrup is poured over the warm dessert. The dessert is rested for 2 hours, then sliced and served.

Nutrients Compositions (per serving)				
Energy (kcal): 418.6	Protein (g): 7.9	Fat (g): 18.4	Carbohydrate (g): 55.8	Dietary Fiber (g): 4.9
Calcium (mg): 92.7	Iron (mg): 3.1		Magnesium (mg): 86.4	Phosphorus (mg): 214.8

Note: Recipes were developed, prepared, and documented by the researcher

According to the data presented in Table 6, the energy content of one serving (125 g) of nevzine dessert prepared using teff flour is 418.6 kcal. The dessert contains 7.9 g protein, 55.8 g carbohydrates, 18.4 g fat, and 4.9 g dietary fiber per serving. In terms of mineral composition, one serving provides calcium (92.7 mg), iron (3,1mg), magnesium (86.4 mg), and phosphorus (214.8 mg).

Table 7. Standard Recipe and Nutrient Composition per Serving of Akıtma (Crêpe)

Dish Name: Akıtma (Crêpe)
Number of Servings: 1
Serving Size (g/ml): 100 g
Preparation Technique: Pan-frying

Ingredients	Amount	Weight (g/ml)	Preparation Method
Eggs	25	g	The egg is cracked into a bowl.
Milk	50	ml	Milk is added to the bowl and whisked together with the egg.
Teff flour	23	g	Teff flour is added to the mixture.
Baking powder	1	g	Baking powder is added to the bowl.
Salt	1	g	Salt is added. The mixture is thoroughly mixed and rested for 5 minutes. A preheated pan is lightly greased with olive oil. The batter is poured thinly into the pan, and the crêpe is cooked on both sides.

Nutrients Compositions (per serving)				
Energy (kcal): 152.3	Protein (g): 6.9	Fat (g): 4.8	Carbohydrate (g): 19.6	Dietary Fiber (g): 1.7
Calcium (mg): 96.4.	Iron (mg): 1.2		Magnesium (mg): 18.9	Phosphorus (mg): 218.6

Note: Recipes were developed, prepared, and documented by the researcher

According to the findings presented in Table 7, the energy content of one serving (100 g) of akıtma (crepe) prepared with teff flour is 152.3 kcal. The product contains 6.9 g protein, 19.6 g carbohydrates, 4.8 g fat, and 1.7 g dietary fiber per serving. The calcium 96.4 mg, iron 1.2 mg, magnesium 18.9 mg, and phosphorus 218.6 mg contents of one serving of akıtma were calculated accordingly.

Conclusion and Suggestions

This study evaluated the applicability of teff, a naturally gluten-free and nutritionally favorable cereal, in different food groups within traditional Turkish cuisine. The recipes developed for tarhana, fellah köftesi, kısır, nevzine dessert, and akıtma demonstrated that teff can be successfully incorporated into diverse product structures and cooking techniques while largely preserving the characteristic features of traditional dishes. These findings indicate that teff may serve as a viable alternative cereal ingredient in traditional Turkish recipes.

The nutritional calculations revealed a notable contribution of teff to mineral and dietary fiber content. In particular, the teff-based tarhana, produced through fermentation, exhibited a favorable mineral profile, including calcium, magnesium, and phosphorus. Considering previous research indicating that fermentation may reduce phytic acid and enhance mineral bioavailability, the observed mineral values may be associated with the combined effects of teff composition and fermentation.

In the fellah köftesi and kısır samples prepared using whole-grain teff, dietary fiber and micronutrient levels were estimated to be higher compared to conventional wheat- or bulgur-based formulations. This observation aligns with existing literature emphasizing the nutritional advantages of whole-grain ingredients. Similarly, in the nevzine dessert and akıtma samples, replacing refined wheat flour with teff flour suggests a potential improvement in nutritional quality, particularly in terms of mineral content.

Although teff lacks gluten-forming protein fractions, which may influence texture and structural development, the selected traditional recipes appeared to accommodate this limitation due to their preparation techniques and product characteristics. This indicates that certain traditional Turkish dishes may be inherently suitable for gluten-free reformulation.

Future research may focus on optimizing formulation ratios, conducting sensory evaluations, and performing comparative analyses between teff and conventional cereal-based formulations. In addition, examining the effects of different processing methods such as fermentation, boiling, and baking on nutrient retention and bioavailability may provide further insight into the nutritional and gastronomic potential of teff in traditional cuisine.

Limitations

This study was limited to descriptive nutritional evaluation and recipe reformulation and did not include sensory analysis, consumer acceptability testing, or experimental comparison with traditional wheat-based formulations. Additionally, nutrient calculations were based on standardized recipe data and software database values rather than laboratory analyses. Therefore, the findings should be interpreted within the context of nutritional estimation and culinary applicability. Future studies may incorporate sensory evaluation, textural assessment, and comparative experimental designs to further examine the gastronomic performance of teff-based adaptations.

Referances

Abebe, Y., Bogale, A., Hambidge, K.M., Stoecker, B.J., Bailey, K. and Gibson, R.S. (2007) Phytate, Zinc, Iron and Calcium Content of Selected Raw and Prepared Foods Consumed in Rural Sidama, Southern Ethiopia, and Implications for Bioavailability. *Journal of Food Composition and Analysis*, 20, 161-168.

Abegaz, K. (2013). Isolation, characterization and identification of lactic acid bacteria involved in traditional fermentation of borde, an Ethiopian cereal beverage. *African Journal of Food Science Research Vol*. 1 (3), pp. 024-032.

Alaunyte, I., Stojceska, V., Plunkett, A., Ainsworth, P. and Derbyshire, E. (2012). Improving the quality of nutrient-rich teff-based gluten-free bread by incorporation of dairy proteins. *Journal of Cereal Science, 55*(1), 22–30.

Allen, B. and Orfila, C. (2018). The availability and nutritional adequacy of gluten-free bread and pasta. *Nutrients***,** 10 **(**10), 1370.

Amare, E., Mouquet-Rivier, C., Picq, C. (2015). Adequacy of iron and zinc content and estimated bioavailability in commercially available complementary foods in Ethiopia. *European Journal of Nutrition &Food Safety* 5(5):438-439.

Arendt, E. K. and Dal Bello, F. (2008). *Gluten-free cereal products and beverages*. Academic Press.

Ashenafi, M. and Mehari, T. (1995). Microbiology of siljo, a traditional Ethiopian fermented legume product. *World Journal of Microbiology and Biotechnology* 11(3): 338-42.

Assefa, K., Yu, J. K., Zeid, M., Belay, G., Tefera, H. and Sorrells, M. E. (2011). Breeding tef [*Eragrostis tef* (Zucc.) trotter]: conventional and molecular approaches, *Plant Breed*, 130(1). 1-9.

Blandino, A., Al-Aseeri, M. E., Pandiella, S. S., Cantero, D. and Webb, C. (2003). Cereal-based fermented foods and beverages. *Food Research International, 36*(6), 527–543.

Baye, K. (2014). Teff: Nutrient composition and health benefits. *International Food Policy Research Institute Working Paper*.

Brouns, F., Van Buul, V., Shewry, P. (2013). Does wheat make us fat and sick? *Journal of Cereal Science, 58*(2), 209–215.

Bultosa, G. (2007). Physicochemical characteristics of grain and flour in 13 teff (*Eragrostis tef*). *Journal of Applied Sciences Research, 3*(12), 2042-2051.

Bultosa, G. and Taylor, J. R. N. (2002). Teff. In J. R. N. Taylor & J. Bélton (Eds.), *Pseudocereals and less common cereals* (pp. 200-203). Springer.

Cochrane,T. (2022). Colonial entanglements and African Health world. *Medicine Anthropology Theory*, Reviews.

Campo, E., Del Arco, L., Urtasun, L. and Oria, R. (2016). Impact of sourdough on sensory properties and consumers' preference of gluten-free breads enriched with teff flour. *Journal of Cereal Science, 67*, 84–90.

D'Andrea, A. C. (2008). T'ef (*Eragrostis tef*) in ancient agricultural systems of Highland Ethiopia. *Economic Botany 62*(4), 547-566.

Fry, L., Madden, A. M., Fallaize, R. (2018). *An investigation into the nutritional composition and cost of gluten-free versus regular food products. Journal of Human Nutrition and Dietetics*, 31(1), 108–120.

Gallagher, E., Gormley, T. R., Arendt, E. K. (2004). Recent advances in the formulation of gluten-free cereal-based products. *Trends in Food Science & Technology*, 143–152.

Gebremariam, M. M., Zarnkow, M., Becker, T. (2014). 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, 51*(11), 2881–2895.

Hager, A. S., Wolter, A., Czerfny, M., Bez, J., Zannini, E. and Arendt, E. K. (2012). Investigation of product quality, sensory profile and ultrastructure of breads made from a range of commercial gluten-free flours compared to their wheat counterparts. *European Food Research and Tecnology*, 235(2):333-344

Hotz, C. and Gibson, R. S. (2007). Traditional food-processing and preparation practices to enhance the bioavailability of micronutrients in plant-based diets. *The Journal of Nutrition, 137*(4), 1097–1100.

Ketema, S. (1997). Tef Eragrostis tef (Zucc.) Trotter. Promoting the Conservation and Use of Underutilized and Neglected Crops, *Leibniz Institute of Plant Genetics and Crop Plant Research*;12, 50.

Long, L. M. (2015). Culinary tourism and the remaking of ethnic food. *Food, Culture & Society, 18*(2), 243–259.

Mancebo, C. M., Picón, J., Gómez, M. (2015). Effect of flour properties on the quality characteristics of gluten free sugar-snap cookies. *Nutritional Medicine, 64(1).*

Mengesha, M.H. (1966). Chemical composition of teff (Eragrostis tef) compared with that of wheat, barley and grain sorghum. *Economic Botany*, *20*(3), 268–273.

Melini, F. and Melini, V. (2019). Gluten-free diet: Gaps and needs. *Nutrients, 11*(1), 1–18.

Minten, B., Tamru, S., Engida, E. and Kuma, T. (2013). Ethiopia's value chains on the move: The case of teff. *International Food Policy Research Institute,* ESSP working papers 52.

Özköse, A., Acar, B., Kamacı, M. (2022). A New Plant for Turkey Teff. Conference: *1st International Conference on Sustainable Ecological Agriculture* (1st ICSEA) March 8-10, Konya, Türkiye.

Ray, K. (2016). *The ethnic restaurateur*. Bloomsbury Academic.

Ronda, F., Pérez-Quirce, S., Villanueva, M. and Collar, C. (2017). Rheological Properties of Gluten-Free Bread Doughs: Relationship With Bread Quality. *Advances in Food Rheology and its Applications* (pp.297-334).

Satheesh, N. and Fanta, S. W. (2018). Review on structural, nutritional and anti-nutritional composition of Teff (Eragrostis tef) in comparison with Quinoa (Chenopodium quinoa Willd.) *Cogent Food & Agriculture,4(1).*

Saturni, L., Ferretti, G., Bacchetti, T. (2010). The gluten-free diet. *Nutrition, 26*(9), 936–939.

Shumoy, H. and Raes, K. (2016). Antioxidant Potentials and Phenolic Composition of Tef Varieties: An Indigenous Ethiopian Cereal. *Cereal Chemistry*. Volume-*93*,465-470.

Spaenij-Dekking, L., Kooy-Winkelaar, Y., Koning, F. (2005). The Ethiopian cereal teff in celiac disease. *The New England Journal of Medicine 353*(16), 1748–9.

Tafere, G. (2015). A review on traditional fermented beverages of Ethiopian. Journal of Natural Seciences Research, 5(15), 94-102.

Thompson, T., Dennis, M., Higgins, L. A., Lee, A. R. and Sharrett, M. K. (2005). Gluten-free diet survey: Are Americans with celiac disease consuming recommended amounts of fiber, iron, calcium, and grain foods*? Journal of Human Nutrition and Dietetics,* 18(3), 163–169.

United States Department of Agriculture, Agricultural Research Service. (2026). *FoodData Central (SR Legacy foods)*. U.S. Department of Agriculture. https://fdc.nal.usda.gov

Slavin, J. L. (2004). Whole grains and human health. *Nutrition Research Reviews*, 17**(**1), 99–110.

Yetneberk, S., Rooney, L. W., Taylor, J. R. N. (2005). Improving the quality of sorghum injera by decortication and compositing with teff. *Journal of the Science of Food and Agriculture*, 85(8):1252 – 1258.

Zhu, F. (2018). Chemical composition and food uses of teff (*Eragrostis tef*). *Food Chemistry*, *239*, 402–415.