IJPSR (2020), Volume 11, Issue 12 (Review Article)

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 10 January 2020; received in revised form, 10 May 2020; accepted, 24 November 2020; published 01 December 2020

TEFF MILLET: NUTRITIONAL, PHYTOCHEMICAL AND ANTIOXIDANT POTENTIAL

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Keywords:

Flavonoids, gluten-free food, nutraceutical, saponin, tannin

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ABSTRACT: Teff millet is progressively gaining importance worldwide due to its recognition as gluten-free food. Interestingly, its attractive nutritional profile and additional functions related to maintaining health play an important role in its identification as a nutraceutical food. The present study was conducted to analyze the nutritional, phytochemical, and antioxidant properties of teff millet. Moisture, ash, fat, fiber, protein, and carbohydrate were analyzed in this study. Minerals like calcium, iron, phosphorus, and zinc were also estimated. Result on proximate analysis showed moisture (10.5 g / 100 g), ash (2.2 g / 100 g), fat (0.5g/ 100 g), fibre (2.8 g / 100 g), protein (10.9 g / 100 g) and carbohydrate (73.1 g / 100 g) respectively. Result on mineral composition showed Calcium (168.1 mg /100 g), iron (13.1 mg / 100 g), phosphorus (420.2 mg / 100 g) and zinc (4.5 mg / 100 g) were also found in teff millet. The presence of different macro as well as micronutrients was recorded in teff millet. Phytochemical analysis indicated the presence of flavonoids, saponins, tannin, glycosides, and steroids. The study showed that teff millet has high antioxidant activity such as DPPH. Therefore, it can be beneficial for celiac disease, hypertension, anemia, diabetes, and cancer condition. The development of food products incorporated by teff millet as a nutraceutical food can improve health and prevent different disease and disorders.

INTRODUCTION: Teff [Eragrostis teff (Zucc.)] is an ancient and indigenous cereal crop. It is considered a staple food in Ethiopia. Apart from Ethiopia, India, Australia, and other European countries are the main areas where it is grown. Its gluten-free nature has made it popular among the researchers [1]. Teff is not only gluten-free but also naturally has a higher content of macro and as well as micronutrients such as calcium, iron and zinc, which make it a very good alternative in gluten-free products.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.11(12).6005-09

The article can be accessed online on www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.11(12).6005-09

It contains a good amount of protein including all the essential amino acids especially lysine, which is most often deficient in grains. One more characteristic of this cereal is its small size because of which teff can be made into whole-grain flour (bran and germ included), this enables very high fiber content in the cereal, and thus, it is useful to improve the hemoglobin level in the human body which can prevent malaria and incidences of anemia [2].

Teff millets are low on the glycemic index, which makes them suitable for people with Type 2 diabetes [3]. Apart from different nutrients, many bioactive compounds are also present in teff millet, such as protocatechuic, gentisic, vanillic, and syringic [4]. They perform as natural antioxidants in the human body and perhaps can be useful in the food industries as well.

The qualitative value of teff as a gluten-free millet united with its nutritional value and health benefits has attracted global interest in its consumption compared to the other major cereal crops. The crude protein, crude fiber, fat, and starch concentrations of teff grain are either similar or superior to those of maize, oat, sorghum, wheat and quinoa in general. Due to the many health benefits of this gluten-free product, the demand for teff grain has increased over the last decade globally [5]. The aim of the study is to aware people with neutraceutical properties of teff millet as there is limited literature on the nutritional, phytochemical, and antioxidant potential of the teff millet.

MATERIALS AND METHODS:

Collection of Plant Material: The seeds were obtained from the local market. The seeds were dried at 100 ºC in an oven for half an hour. The dried sample of seeds was milled with a mechanical blender, and their storage was done in air-tight containers in a refrigerator for carrying out analysis further.

Reagents: In this experiment, the used nitric acid and per caloric acid were purchased from Merck, India. For standard calibration of respective elements, we purchased Ca, Fe, P, and Zn standard solution (100 mg/ml) from Sigma Company Mumbai, India. We prepared the respective desires from the stock solution using lab-made double distilled water.

Determination of Proximate Composition: Seeds powder was taken in a clean, dry, and weighed crucible. It was oven-dried later on at 110 ºC. It was weighed repeatedly until a constant weight was acquired. The crucible was cool down in desiccators every time before weighing. Proximate analysis included the estimation of moisture, ash, fat, protein, crude fiber, and carbohydrate of seeds. Total ash was estimated by weighing the furnace in incinerated residue at 550 ºC for 12 h. Protein was analyzed by using Micro-kjeldahl distillation method. Determination of carbohydrate content was done through the different method.

Determination of Minerals: Chemical estimations were carried out for determining calcium (Ca), iron (Fe), phosphorus (P), and zinc (Zn). The estimation of Ca, Fe, Mg, P, and Zn was done by using atomic absorption spectrophotometer (AAS) (model VGP 210, Buck Scientific, USA).

The data recorded for respective elements was done in triplicate measurements for its authentication and used for standard deviation calculation.

Phytochemical Screening: The teff millets seeds were screened for phytochemicals (flavonoids, saponin, tannins, alkaloids, steroids, and glycosides) according to the procedure given [6].

Statistical Analysis: All the results were shown in Mean and Standard Deviation.

RESULTS AND DISCUSSION: In this study, the nutritional compositions are shown in table 1 in which protein content was found in an appreciable amount. Minerals including calcium and iron were present in an adequate amount

TABLE 1: NUTRITIONAL COMPOSITION OF TEFF MILLET FLOUR

Nutrients (per 100g)	Amount
Moisture(g)	10.5 ±0.1
Ash (g)	2.2 ± 0.2
Fat (g)	0.5 ± 0.1
Fibre (g)	2.8 ± 0.2
Protein (g)	10.9 ± 0.1
Carbohydrate (g)	73.1 ± 0.4
Calcium (mg)	168.1 ± 0.3
Iron (mg)	13.1 ± 0.2
Phosphorus (mg)	420.2 ± 0.1
Zinc (mg)	4.5 ± 0.1

The value of the proximate composition of seed powder of teff is represented through **Table 1**. The table depicts the Mean ± SEM (g / 100 g) of moisture, ash, fat, fiber, protein, carbohydrate, calcium, iron, phosphorus, and zinc content. The proximate data revealed that the moisture content (g/100 g) was low (10.5 ± 0.1), which was in close agreement with the results of Heiru *et al.,* [7] that moisture content of teff seed was (10.5±0.0). It will be advantageous to prolong the seeds' shelf life because its presence in high amounts could result in fatty acids decomposition through microbial action. The ash content (g / 100 g) of seed was found to be 2.2 ± 0.2. Similar results were found in a study conducted by Nascimento *et al.,* 8 that is 2.7 ± 0.1. The presence of ash in any seed sample shows the presence of minerals. The fat content (g / 100 g) of teff seed was 0.5 ± 0.2. On the contrary, a slightly increased amount was seen in a study conducted by

Inglett *et al.*, [9] that is 2.38. It provides essential fatty acids (EFA) and helps in fat-soluble vitamin absorption, including A, D, E, and K. It acts as a substrate in producing hormones and mediators. It plays a significant role in infancy and early childhood because it is important in the neurological development and functioning of brain. The fiber content (g / 100 g) of seed (2.8 ± 0.2) was in close agreement with the results of Satheesh and Fanta 10 that the fiber content of teff seed was 3.0.

A high fiber diet plays an important role in preventing a number of human diseases such as colon cancer, diabetes, and weight loss. The protein content (g/100 g) of the seed was 10.9 ± 0.1. A similar study was found in a study conducted by Akansha *et al.*, [11] that is 11.0. It is a vital source of the nutrient. Apart from contribution in the diet, the relative impact of proteins in the body must not be unnoticed. In the form of chemical compounds, depleted cells are repaired and replaced, structural and globular materials which hold the body are formed, blood proteins are formed, the immune system is boosted by them, *etc.* [12] The seeds were abundant in carbohydrate content (73.1 ± 0.4 g / 100 g), which was similar with the findings of Nascimento *et al.*, [8] had carbohydrate in range of 73.1 g/100 g.

The minerals obtained in teff seed was calcium, iron, phosphorus, and zinc, with the content (mg/100 g) recorded (168.1 ± 0.3, 13.1 ± 0.2, 420.2 ± 0.1, and 4.5 ± 0.1). The amount of calcium and iron was comparable with the findings of Bultosa, 13 in which teff had a range between (11.6- >150, 18-178). Osteoporosis has become one of the most serious public health problems across the world. Calcium intake can prevent this and other bone-related disorders [14]. Iron is an essential nutrient in the maintenance of normal cell metabolism. Apart from it, iron also enables functions like ATP production, DNA synthesis, and oxygen transport by the use of iron-containing enzymes [15].

Phosphorus also plays various necessary functions in the body, such as it is involved in a range of cellular processes, including maintenance of membrane structures, synthesis of biomolecules, the formation of high-energy molecules, cell division, and enzyme activation/inactivation. Carbohydrate metabolism is also one of its important features [16]. Maares and Haase, [17] reported that zinc is important for gene expression, which desired the activity of a variety of metallo enzymes. It also plays a crucial role in various processes like differentiation, apoptosis, and proliferation, influencing an organism's growth and development.

TABLE 2: PHYTOCHEMICAL SCREENING OF TEFF MILLET FLOUR

Phytochemical	Teff millet seeds
Flavonoids	+
Saponin	+
Tannin	+
Glycosides	+
Steroids	+

The results for phytochemicals estimation showed the presence of flavonoids, saponin, tannin, glycosides, and steroids. The qualitative analysis of phytochemicals of the aqueous extracts of teff seed power showed positive results for the presence of flavonoids, saponin, tannin, glycosides, and steroid, which are shown in **Table 2**. Epidemiological and animal studies have suggested that intake of fruits, vegetables, and whole grains on a regular basis helps to reduce the chronic diseases risk having an association with oxidative damage.

Flavonoids are associated with biochemical and antioxidant effects in the body, which are helpful in the prevention of various diseases such as cancer, atherosclerosis, and Alzheimer's disease. It also shows anti-inflammatory, antiallergic, and anti-microbial activities.

Studies have reported flavonoids of preventing low-density lipoprotein oxidation and thus preventing atherosclerosis development [18]. Saponin possesses a range of compounds which has antibiotic properties and is believed to protect the living body against hypercholesterolemia.

Activities of the Central nervous system are also responsible for Saponins, and it is used to create tonics for treating depression and neurasthenia [19]. The confirmation by many studies has been provided of tannins exhibiting anti-oxidant, anti-microbial, and anti-inflammatory properties. Consuming foods rich in tannins can provide many remedial and valuable functions to a person. Utilization of tannins as drugs can be beneficial in healing the burning injury and stop the bleeding from cuts.

Tannins possess the capability of forming a leather resistance upon the exposed tissues and leads to protection of the wounds from being affected afterward [20]. Steroid hormones have significant roles in human physiology. It helps to avoid some diseases like cardiovascular disease and reduce the risk of coronary heart disease [21].

DPPH Activity: The DPPH is a stable nitrogen-centered free radical with a maximum absorption band of approximately 515 to 528 nm. In this assay, the antioxidants decrease the DPPH radical (purple color) to a compound being yellow in color, 1, 1diphenylpicrylhydrazine [22]. The extent of color change is dependent upon the hydrogen donating ability of the antioxidants. DPPH assay is based on the ability of DPPH, which is a stable free radical that decolorizes in the presence of antioxidants [23]. It is a direct and reliable technique to determine radical scavenging action.

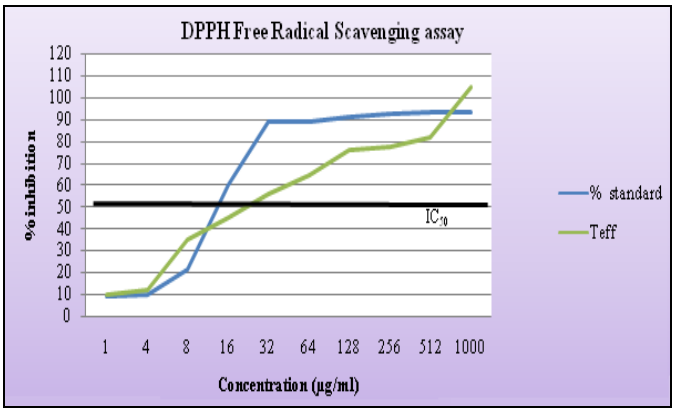

FIG. 1: DPPH FREE RADICAL SCAVENGING ASSAY OF TEFF MILLET FLOUR

The DPPH scavenging activities of aqueous extract were evaluated by using the parameters IC_{50} which means the concentration of antioxidant required for 50% scavenging of DPPH radical in the particular time period [24]. *In-vitro* activity of teff millet, the extract was measured with the standard antioxidant (Ascorbic acid). The antioxidant activity of teff millet exhibits antioxidant activity with IC_{50} (inhibitory concentration) ranged from 16 to 32 µg/ml.

CONCLUSION: Teff millet comes out to be a healthful source as it contains all macro and micro nutrients in adequate amounts. Its usefulness lies in gluten-free products for celiac patients as it can be nutritionally adequate and easily acceptable by them. It can come out as an outstanding source of gluten-free products compared to those available in the market because of all the essential nutrients present in adequate amounts without compromising the taste of consumers.

ACKNOWLEDGEMENT: The authors are thankful to the Department of Food Science and Nutrition, Banasthali Vidyapith, for providing necessary laboratory facilities.

CONFLICTS OF INTEREST: The authors declare that there is no conflict of interest regarding the publication of this paper.

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How to cite this article:
Akansha and Chauhan ES: Teff millet: nutritional, phytochemical and antioxidant potential. Int J Pharm Sci & Res 2020; 11(12): 6005-09. doi: 10.13040/IJPSR.0975-8232.11(12).6005-09.