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Nutrition of Tef (Eragrostis tef) Recipes

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Abstract
Tef *(Eragrostis tef* (Zucc.) Trotter) grown in Ethiopia predominantly is used to make injera, flatbread or flat pancake like fermented bread. Globally it is being found in health food stores for its long least of health benefits. It is an excellent gluten-free flour alternative, and being used to make pie crusts, cookies, breads, and an assortment of other baked goods. Eighteen teff recipes was studied. Direct analytical techniques for determination of the carbohydrate, Kjeldahl method for protein and total dietary fiber were used, and Calories by calculation. Macronutrients (fat, protein, carbohydrate, and total dietary fiber) in the teff recipes were determined where on average 0.17, 0.08, 0.48, and 0.05 per gram of the recipe were found to be fat, protein, carbohydrate and total dietary fiber respectively. These recipes also found to have a capacity of providing 814 – 4649 calories of energy from a 231 – 1250 gram of the mix of which teff is contributing 27 – 152 grams. The recipes suffice the Codex standard for infants, and supply much more amount of carbohydrate than the minimum recommended for adult at different activity level. Similar attribute is seen for the total dietary fiber and calories content.
Keywords: teff, recipes, teff recipes, teff nutrition

INTRODUCTION

Tef *(Eragrostis tef* (Zucc.) Trotter) is a fine grain that comes in a variety of colors, from white and red to dark brown. It is native and an important cereal crop to Ethiopia which is believed to be originated between 4000 and 1000 BC (Ponti, 1978). This record traces back to ancient civilizations of Abyssinia, tef as a reliable support to our early ancestors' survival. Hitherto it is grown predominantly in this country and used to make injera (flatbread or flat pancake like fermented bread). Currently it is cultivated on over 30% (3,016,063 ha) of the area used for cereals and accounts for 20% (47,506,624 quintals) of the total cereal production in this country (CSA, 2014/15).

Tef is leading all cereal grains by a wide margin having a high concentration of a variety of nutrients, most of which are easily absorbed by human body at most. Such as in mineral nutrients including calcium, thiamin, iron, copper, zinc, aluminum, molybdenum, barium and silicon oxide; and amino acids such as phenylalanine, tyrosine, threonine, histidine and methionine (Seyfu Ketma, 1997).

Outside Ethiopia there is a growing interest in using tef, usually being found in health food stores either in the grain form or ground into flour, for a long list of health benefits. It frequently been ground into flour to make excellent gluten-free flour alternative, and be used to make pie crusts, cookies, breads, and an assortment of other baked goods. Similarly, being eaten whole and steamed, boiled, or baked as a side dish or a main course. It is this use thus motivated the current study on the nutrition of it among the different uses listed above.

MATHERIALS AND METHODS

Recognising the important role of tef it plays in the healthy nutrition to human population in Ethiopia and globally at large, the nutritional investigation on 18 recipes of tef made.

Among the most powerful direct analytical techniques of chromatographic methods High Performance Liquid chromatography (HPLC) were used for the analysis and determination of the content of carbohydrate (Sluiter et al. the National Renewable Energy Laboratory, 2011). Determination of protein performed following the Kjeldahl method procedure (AOAC, 2000). The total dietary fiber determined based on AOAC Official methods (AOAC 985.29). Calories values were calculated based on calculation of the energy content of food - energy conversion factors (FAO, 2003; Youdim, 2013).

RESULT

The tef recipes composed of different type of food ingredients which brings difference in available nutrients. Macronutrients (fat, protein, carbohydrates, total dietary fibers and the calories obtained per round of preparation) found in the eighteen tef recipes determined in this work are presented in table 1. The constituent fall in the range of 17 – 284, 12 – 213, 141 – 692, and 16 – 77 grams per preparation of the recipes in fat, protein, carbohydrate, and total dietary fiber respectively. That is, on average fat comprises 0.17 per gram, protein 0.08 per gram, carbohydrate 0.48 per gram, and total dietary fiber 0.05 per gram of the recipe. This nutrient rich recipe of tef can provide 814 – 4649 calories of energy from each preparation that ranges from 231 – 1250 grams

of the mixings, which varies among the recipes (Table 1). In these mixes we found tef as a component, contributing 4.4 – 56.7% to the recipe (Table 1). Most of the recipes that contain tef above 20% as component are showing release of calories at less level (Table 2).

Table 1. Macronutrients available in the tef recipes

Recipes	Quantity of recipe (g)	Proportion of teff (%)	Fat (g)	Protein (g)	Carbohydrate (g)	Total dietary fiber (g)	Calories (cal)
Raspberry teff muffins	1250	4.4	229	32	615	48	4649
Banana teff energy bar	1200	5.5	201	49	628	49	4517
Pumpkin teff energy bar	1148	5.7	200	50	592	52	4368
Apple crisp with rice syrup	560	4.9	49	26	306	41	1769
Apple crisp with maple syrup	620	4.4	69	26	318	41	1997
Pear crisp with rice syrup	508	5.4	68	27	285	41	1860
Pear crisp with maple syrup	567	4.9	68	27	297	41	1908
Mocha tofu apricot teff pie with rice syrup	779	16.8	128	213	315	39	3264
Mocha tofu apricot teff pie with maple syrup	899	14.6	129	213	339	39	3369
Lemon poppy seed cake	1239	12.3	153	72	692	77	4433
Mocha teff scones	483	28.4	75	18	245	27	1727
Peanut butter cookies	681	12.1	241	74	219	28	3341
Dessert pie crest	423	26	111	12	188	16	1799
Teff banana pancakes	333	24.8	39	25	172	26	1139
Teff polenta	231	56.7	17	24	147	25	837
Wheat – gluten free	690	10	284	55	202	40	3584
Teff pancakes with pear juice	274.5	40	31	12	153	17	939
Teff pancakes with apple juice	246	44.7	30	12	141	16	882

The amount of tef (grain/flour) used for each recipe was in the range from 27 – 152 grams. These volumes of tef have different levels of contribution to each macronutrients in the recipes studied (Table 2). Its contribution to the protein level in the recipes found in the range of 9 – 100%, 7 – 67% for carbohydrate, 10 – 100% for total dietary fiber and 4 – 59% for calories in the recipes. The 100% contribution of tef for protein was seen in ‘Desert pie crest’ and ‘Tef pancakes with pear juice’, and for total dietary fiber was in ‘Desert pie crest’. At large, one can see the nutritional value and contribution of tef in daily diet of the consumer regardless of the health matter.

Table 2. Teff contribution for each nutrient component/recipes

Recipes	Quantity of recipe (g)	Tef portion (g)	Protein (%)	Carbohydrate (%)	Total dietary fiber (%)	Calories (%)
Raspberry teff muffins	1250	55	19	7	17	4
Banana teff energy bar	1200	66	16	8	18	6
Pumpkin teff energy bar	1148	65	15	8	17	6
Apple crisp with rice syrup	560	27	11	7	10	5
Apple crisp with maple syrup	620	27	11	6	10	5
Pear crisp with rice syrup	508	27	11	7	10	6
Pear crisp with maple syrup	567	28	11	7	10	6
Mocha tofu apricot teff pie with rice syrup	779	131	9	32	27	16
Mocha tofu apricot teff pie with maple syrup	899	131	9	29	27	15
Lemon poppy seed cake	1239	152	28	16	21	16
Mocha teff scones	483	137	82	41	74	29
Peanut butter cookies	681	82	12	27	44	10
Dessert pie crest	423	110	100	43	100	23
Teff banana pancakes	333	83	36	35	46	28
Teff polenta	231	131	79	67	44	59
Wheat – gluten free	690	69	14	25	25	7
Teff pancakes with apple juice	274.5	110	97	52	97	42
Teff pancakes with pear juice	246	110	100	57	99	44

The calorie content of the recipes, in this case, depends on the amount of carbohydrate, protein, fat. These components contribute different amounts of calories to the overall recipe (Table 3).

Table 3. Relative proportion of fat, carbohydrate, and protein in the calorie profile of the recipe

Recipes	Fat	Protein	Carbohydrate
Raspberry teff muffins	44.3	2.8	52.9
Banana teff energy bar	40	4.3	55.6
Pumpkin teff energy bar	41.2	4.6	54.2
Apple crisp with rice syrup	24.9	5.9	69.2
Apple crisp with maple syrup	31.1	5.2	63.7
Pear crisp with rice syrup	32.9	5.8	61.3
Pear crisp with maple syrup	32.1	5.7	62.3
Mocha tofu apricot teff pie with rice syrup	35.3	26	38.6
Mocha tofu apricot teff pie with maple syrup	34.5	25	40.2
Lemon poppy seed cake	31.1	6.5	62.4
Mocha teff scones	39.1	4.2	56.7
Peanut butter cookies	64.9	8.9	26.2
Dessert pie crest	55.5	2.7	41.8
Teff banana pancakes	30.8	8.8	60.4
Teff polenta	18.3	11	70.3
Wheat – gluten free	71.3	6.1	22.5
Teff pancakes with apple juice	29.7	5.1	65.2
Teff pancakes with pear juice	30.6	5.4	63.9

DISCUSSION

Today, teff is found in a variety of products like pancakes, breads, cereals, snack bars and many other foods for its nutritional punch in a diet that give an excellent combination of benefits. This study reveals the nutrition of

the recipes and nutritional contribution of teff in the recipe.

Protein in the recipes

Proteins are important constituents of foods for a number of different reasons. They are a major source of *energy*, as well as containing essential amino-acids, such as lysine, tryptophan, methionine, leucine, isoleucine and valine, which are essential to human health, but which the body cannot synthesize. A great combination of twelve essential amino acids that are comparable with the contents of whole egg needed for the body's growth and repair (Seyfu Ketma, 1997) are found as a constituent in tef. The amino acid content in 1 cup of raw teff, most the recipes studied in this work contain, is sufficient to produce 51 percent of the recommended daily intake for protein (WHO/FAO/UNU Expert Consultation, 2002; Institute of Medicine of the National Academies, 2005; Watkins, 2011; Australia New Zealand Food Standards, 2015).

All the recipes except 'Mocha tofu apricot teff pie with rice syrup and with maple syrup' (Table 1) suffice the Codex standard 156 (1987 amended 1989, 2011) for infants, quantity of protein not exceed 5.5g per 100 available calories.

A higher protein intake is common for this tef recipes users. Presently, diet of this type is recommended for the elderly and especially the frail population which may minimize the sarcopenia of aging and thereby protect against some of the health risks of aging (Morais et al., 2006).

Carbohydrate in the recipes

The roles of carbohydrate in the body includes providing energy for working muscles, providing fuel for the central nervous system, enabling fat metabolism, and preventing protein from being used as energy. Carbohydrate is the preferred source of energy or fuel for muscle contraction and biologic work. Carbohydrates serve as a primary energy source in the diet and provide 4 calories per gram of carbohydrate (University of California, 2005; Insel and Roth, 2010; Iowa State University Extension and Outreach, 2015; Stephenson and Schiff, 2015).

Some common foods containing complex carbohydrate include bread, pasta, and whole grains, the case in this recipes. Complex carbohydrates take a longer time to digest and absorb. This creates a slow and steady increase in blood glucose and a slow and steady increase in insulin levels.

The minimum recommended intake of carbohydrates necessary for survival is 130 grams or 520 kcal per day (Iowa State University Extension and Outreach, 2015), where the recipes are saturated at much more amount (Table 1). With this respect, the teff component of the recipes on average is providing 50% of the minimum requirement, in the range of 19 (Apple crisp with maple syrup) to 111 (Lemon poppy seed cake) grams carbohydrate (Table 2).

Total dietary fiber in the recipes

Fiber is a complex carbohydrate, and can be classified as soluble or insoluble. Soluble fiber can be broken down and provides energy. Soluble fiber is found in many fruits and vegetables including green leafy vegetables, celery, carrots, apples, pears, among others (part and parcel of the teff recipe). Insoluble fiber cannot be digested in our digestive system, and does not provide energy. Insoluble fiber is commonly found in whole grain cereal, bread, and rice (part and parcel of the teff recipe). Insoluble fiber has an important role in health by promoting gut motility and satiety (FAO/WHO, 1998; Iowa State University Extension and Outreach, 2015).

Dietary fiber (FAO/WHO, 1998) is a type of carbohydrate human body cannot break down into energy. The roughage passes through digestive system undigested. High dietary fibers in Teff help provide necessary roughage to large intestine, necessary for bowel movements. Fiber is necessary to create bulk in the intestine to push the stool out, it helps prevent constipation and keeps digestive tract clean. The plant material also helps maintain the cholesterol and sugar in bloodstream at normal levels, keeping this all advantage the tef component seen in table 2 is at good level for nutrition of the recipes. The fiber in 1 cup of uncooked teff represents 62 percent of the recommended daily intake for the nutrient (Watkins, 2011). That is, two cups of Teff is sufficient to provide daily requirement of dietary fibers. Hence, among the teff recipes 'Mocha teff scones', 'Dessert pie crest' and 'Teff pancakes' fall in this group (Table 1). However, all the tef recipes considered in this study fulfilled point mentioned by Watkins (2011) except 'Mocha tofu apricot teff pie' and 'Teff polenta' that have 2/3 cup teff, and 'Apple (pear) crisp' that have ½ cup teff (Table 1). Just like other cereals, Teff grain also provides necessary dietary fibers helpful in preventing intestinal disorder. Teff grains improve peristalsis in the intestine and increase the bulk of the stools, thus keeping internal system clean.

Calories from the recipes

A calorie is the unit used to measure the energy-producing value of food (Sizer and Whitney, 1997; University of California, 2005; Insel and Roth, 2010). The relative proportion of the macronutrients (Fat, protein, and carbohydrate) in the teff recipes contributing to the calories presented (Table 3) of which the upper hand is from carbohydrates. That is, more calories derived from carbohydrate component followed by fat and least from protein. This agrees with most nutrition studies such as University of California (2005); Insel and Roth (2010). The calorie in the recipes (Table 1) fall in the range of Univeristy of California (2005) estimate based on body mass index for the needs per day to maintain human in light activities (1455 – 2910) to heavy activity (1940 –

3880) mentioned; with exception of 'Teff polenta' that have 837, 'Teff pancakes with pear juice' that have 882, and 'Teff banana pancakes' that have 1139.

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