TEFF Study

Teff (The name means "lost", because if you drop it on the ground you won't find It.) is another one of the ancient grains of the world finding resurgence in the modern diet. It originated in Ethiopia as a foraged wild grass and was eventually cultivated by the highland Ethiopians. Seeds of teff have been found in a brick of the Dassur Egyptian pyramid built in 3359 B. C. Today teff straw is still used to make adobe in Ethiopia and it is cultivated for its hay in Kenya and Australia. In the U.S., teff crops are being grown in Idaho.

Ounce for ounce, teff, the smallest grain in the world, supplies more fiber rich bran and nutritious germ than any other grain! It also packs a high mineral content that boasts 17 times the calcium of whole wheat or barley. It takes 150 grains of teff to weigh as much as one grain of wheat which accounts for its high nutritional value - it's about twice the size of the period at the end of this sentence. In any grain the nutrients are concentrated in the germ and bran. With teff the germ and bran make up the bulk of the grain and because it is too small to hull, its nutrients are abundant and stay intact.

Common Names

English: Teff, Love grass, Annual Bunch Grass, Warm Season Annual Bunch Grass

Ethiopian: Tef

Oromigna: Tafi

Tigrigna: Taf

French: mil éthiopien

Also written as: Ttheff, Tteff, Thaff, Tcheff, Thaft, Tcheff. (ANON 1887)

Scientific Names

Synonyms: *E. pilosa* (L.) P. Beauv. var. tef (Zucc.); *E. pilosa* (L.) P. Beauv. subsp. *abyssinica* (Jacq.); *E. abyssinica* (Jacq.) Link.; *Cynodon abyssinicus* (Jacq.) Rasp.; *Poa cerealis* Salisb.; *Poa abyssinica* Jacquin; *Poa tef* Zuccagni

Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order:	Poales
Family:	Poaceae
Subfamily:	Chloridoideae
Genus:	*Eragrostis*
Species:	***E. tef***

Teff is an intriguing grain, ancient, minute in size, and packed with nutrition. Teff is believed to have originated in Ethiopia between 4000 and 1000 BC. Teff seeds were discovered in a pyramid thought to date back to 3359 BC.

The grain has been widely cultivated and used in the countries of Ethiopia, India and its colonies, and Australia. Teff is grown primarily as a cereal crop in Ethiopia where it is ground into flour, fermented for three days then made into injera, a sourdough type flat bread. It is also eaten as porridge and used as an ingredient of home-brewed alcoholic drinks. The grass is grown as forage for cattle and is also used as a component in adobe construction in Ethiopia. At this time it is not widely known or used in the U.S., though it is cultivated in South Dakota and Idaho and is available in many health food stores.

Teff is a fine stemmed, tufted annual grass characterized by a large crown, many shoots, and a shallow diverse root system. The plants germinate quickly and are adapted to environments ranging from drought stress to water logged soil conditions. It is a reliable low risk crop. There are 250 known species of Eragrostis, or love grasses, but only a few are of significant agricultural value.

NUTRITIONAL INFORMATION

Teff is well known by Ethiopians and Eritreans for its superior nutritional quality. It contains 11% protein, 80% complex carbohydrate and 3% fat. It is an excellent source of essential amino acids, especially lysine, the amino acid that is most often deficient in grain foods. Teff contains more lysine than barley, millet, and wheat and slightly less than rice or oats. Teff is also an excellent source of fiber and iron, and has many times the amount of calcium, potassium and other essential minerals found in an equal amount of other grains. When teff is used to make injera, a short fermentation process allows the yeast to generate more vitamins. (http://www.wam.umd.edu/tes/tef/injera.html) Teff is nearly gluten-free, and is gaining popularity in the whole food and Health food industry in the U.S. as an alternative grain for persons with gluten sensitivity. Teff may also have applications for persons with Celiac Disease.

DEMAND FOR TEFF

It would seem that because of its superior nutritional qualities, teff would be available to all persons in Ethiopia to make injera. However, while it is the preferred grain in making injera, its availability is limited by its high cost. Teff is currently the most expensive grain to purchase in Ethiopia as it requires labor-intensive harvesting and processing techniques, and produces especially low yields. Although teff covers the greatest land space in Ethiopia, it has the lowest yield per hectare, an average of 910kg/ha. In 1996-1997, teff covered 31% of the total landmass, as compared to 17% and 13% for corn and wheat respectively. The total yield for the teff grown in that year was only 26-28%. Research is currently under way to improve the yield of this cereal crop both in Ethiopia and in the U.S.

Teff is grown in Ethiopia and Eritrea predominately for human consumption. Other grains grown in Ethiopia and Eritrea include barley, sorghum, wheat, and maize or corn.

In Ethiopia, teff has multiple other uses including acting as reinforcement for thatched roofs and mud bricks. It is sometimes used as

an alcoholic beverage base although most alcoholic beverages in Ethiopia are primarily made from corn and millet. Teff is used in mixtures with soybean, chickpea and other grains and is becoming popular as baby food because of its high mineral content.

When teff grown in other countries such as Uganda, Australia, Canada, the United States and Kenya it is served mainly as animal feed. The use of teff as an animal foodstuff is universal. Both its grain and straw provide an excellent nutritional product in comparison to other animal feed.

With the growing Ethiopian and Eritrean immigrant communities, the demand for teff as an important cereal group continues to rise.

GROWING CONDITIONS

Although teff is found in almost all cereal growing areas of Ethiopia, the major areas of production are the central and highland areas. Teff can resist water-logging conditions associated with these regions; however, initial germination of the seed requires specific attention to prevent seed rot in the ground.

Teff is well adapted to the heavy, well-drained, clay-like soil areas of the Ethiopian highlands where most other cereal crops cannot be grown easily. Teff grows best in moderate altitude levels. The preferred altitude condition for teff is 1700-2200 meters. This matches most closely with altitudes in the highland areas of Ethiopia at 1800-2100 meters.

The 12-hour light schedule that is found in equatorial regions of the world, such as Ethiopia and Eritrea, is the ideal sunlight requirement of the plant. It prevents flowering of the grain referred to as "summer slump". This poses particular challenges when the grain is grown in North America with extended summer daylight conditions. A former Peace Corps volunteer in Michigan has been successful in altering the daylight schedule requirements to prevent "summer slump".

As a result of the increased demands for teff in Ethiopia and the rising popularity of teff as an alternative grain in the U.S., agricultural practices to support increased growth of this crop are needed. Current research in Michigan and Idaho to adjust the light requirements has increased the yields of teff.

The arid lowland areas of Ethiopia support minimal teff production. These areas are sparsely populated because of the severity of the growing season in these regions. Due to its drought-resistant characteristics, the best-suited grain for these growing conditions is millet. The nomadic

people that most often occupy the lowland areas of Ethiopia base their diet predominately on beef and dairy products or Ethiopian bread (*kita* in Amharic and *kitcha* in the Tigrean language) made from millet or barley. Other Ethiopian breads made with yeast are referred to as *Ambasha*.

TYPES OF TEFF

The color of the Teff grains can be ivory, light tan to deep brown or dark reddish brown purple, depending on the variety. Teff has a mild, nutty, and a slight molasses like sweetness. The white teff has a chestnut-like flavor and the darker varieties are earthier and taste more like hazelnuts. The grain is somewhat mucilaginous. It is interesting that documents dated in the late 1800's indicate the upper class consumed the lighter grains, the dark grain was the food of soldiers and servants, and cattle consumed hay made from teff.

White teff is the preferred type but only grows in certain regions of Ethiopia and does not grow in Eritrea. White teff grows only in the Highlands of Ethiopia, requires the most rigorous growing conditions, and is the most expensive form of teff. Just like white bread has been a status symbol in the United States, white teff was reserved for the wealthiest and most prestigious families in Ethiopia. The prestige associated with consuming white teff, as well as its more stringent growing conditions, contributes to the increased cost of white teff. The shelf life of injera is extended with the use of white teff.

Red teff, the least expensive form and the least preferred type, has the highest iron content. In persons living in areas of the country where consumption of red teff is most prevalent, hemoglobin levels were found to be higher with a decreased risk of anemia related to parasitic infection. Today in Ethiopia, red teff is becoming more popular related to its increased iron content. The average iron content of teff is 62.71mg/4oz grain. Studies indicate that the level of iron in the teff is related to the threshing of the grain on the soil. To our knowledge, no studies investigating the iron content of the soil and its possible effect on the iron contents of the grain, have been conducted.

The third main type of teff, *brown teff*, has moderate iron content. Ethiopia is the considered the site of origin of teff. Teff was domesticated in Ethiopia 4000–1000 BC

Crop Status

Teff is an annual grass crop and harvested for grain in Ethiopia. Teff flour is preferred in the production of injera, a major food staple in Ethiopia. Teff is also grown on a limited basis for livestock forage in other

parts of Africa, India, Australia and South America. In the U.S. small acreages of teff are grown for grain production and sold to Ethiopian restaurants (Carlson, Idaho) or utilized as a late planted livestock forage (Larson, Minnesota). The nutritional value of teff grain is similar to the traditional cereals. Teff is considered to have an excellent amino acid composition, lysine levels higher than wheat or barley, and slightly less than rice or oats. Teff contains very little gluten. Teff is also higher in several minerals, particularly iron.

Botany

Physiology

Teff is a C4 annual grass plant having Kranz anatomical characteristics and classified intermediate between tropical and temperate grasses.

Teff is a fine stemmed, tufted annual grass. The plant has the appearance of a bunch grass, having large crowns and many tillers. The inflorescence is an open panicle and produces small seeds (1,000 weigh 0.3 to 0.4 g). The roots are shallow and develop a massive fiberous rooting system. Plant height of teff varies dependent upon cultivar type and growing environments.

Taxonomy

Eragrostis is a member of the tribe *Eragrosteae*, sub-family *Eragrostoidae*, of the Poaceae (Gramineae). There are approximately 300 species in the genus *Eragrostis* consisting of either annuals or perennials which were found over a wide geographic range. *Eragrostis* species are classified based on characteristics of culms, spikelets, lateral veins, pedicels, panicle, flowering scales, and flower scale colors.

Morphology and Floral Biology

Teff is a warm season annual grass, characterized by a large crown, many tillers, and a shallow diverse root system. Teff germplasm is characterized by a wide variation of morphological and agronomic traits. Plant height varies from 25–135 cm, panicle length 11–63 cm, with spikelets numbers per panicle varying from 190–1410. Panicle types vary from loose, lax, compact, multiple branching multi-lateral and unilateral loose to compact forms. Maturity varies from 93–130 days. Grain color ranges from pale white to ivory white and from very light tan to deep brown to reddish brown purple. Teff seed is very small, ranging from 1–1.7mm long and 0.6–1mm diameter with l000 seed weight averaging 0.3–

0.4 grams. Grain and straw yield represented the maximum genetic diversity among the observed teff germplasm. Teff is a self pollinating chasmogamous plant. The florets consist of a lemma, palea, 3 stamens, two stigma and two lodicules. Floret colors vary from white to dark brown. Panicle spikelets consist of 2–12 florets.

Ecology

Teff is adapted to environments ranging from drought stress to water logged soil conditions. Maximum teff production occurs at altitudes of 1800–2100 m, growing season rainfall of 450–550 mm, with a temperature range of 10–27°C. Teff is day length sensitive and flowers best during 12 hours of daylight.

Crop Culture (Agronomy)

Teff can be planted in late May similar to millets. Late plantings have the advantage to control emerged weeds by tillage prior to planting, which can be significant since teff is a poor competitor with weeds during the early growth stages. Seedbed should be firm and prepared similar to planting for alfalfa. Seeding rates are 4.5 to 9.0 kg/ha using implements such as cultipackers or Brillion seeders. Teff should be seeded 12–15 mm deep either broadcast or in narrow rows. Teff germinates rapidly, and the broadcast and narrow row seeding allow for stronger weed competition. Control of broadleaf weeds should be considered, particularly redroot pigweed, which produces seed that cannot be separated from teff. Moderate rates of nitrogen and phosphorus fertilizer are suggested to prevent lodging. Several special considerations must be given to teff harvested for grain. Due to the small seed size, combine seed delivery systems must be checked for gaps and areas through which the small teff seed can be lost. Soil particles must be prevented from going through the combine and into the grain hopper, since it is very difficult if not impossible to separate fine soil particles from the teff grain.

Germplasm

Teff grown in Ethiopia is represented by either landrace selections or developed varieties adapted to specific geographic regions. Examples of teff varieties available in the U.S. are Dessie Summer Love Grass (Carlson, Idaho), S.D. 100, and Bridger. Teff is also grown from selected plant introduction (PI) accessions available from the USDA Western Region Germplasm Center, Pullman, Washington.

Nutritive Value

The nutritive value of teff for livestock fodder is similar to other grasses utilized as hay or ensiled feeds. Digestibility studies of cell wall contents suggest that teff has tropical grass characteristics, protein and digestibility as forage decreases with increased maturity. Protein content of teff forage produced in South Dakota ranged from a high of 19.5 to a low of 12% as the plant matured. In Montana, teff hay protein content ranged from 13.7 to 9.6%. Protein level (10 to 12%) of teff grain is similar to other cereal grains. Teff has high calcium content, and contains high levels of phosphorous, iron, copper, aluminum, barium, and thiamine. The principal use of teff grain for human food is the Ethiopian bread (injera). Injera is a major food staple, and provides approximately two-thirds of the diet in Ethiopia. While the reported high iron content of teff seed has been refuted, the lack of anemia in Ethiopia is considered to be due to the available iron from injera. Injera is described as a soft, porous, thin pancake, which has a sour taste. Teff is low in gluten and therefore, the bread remains quite flat. When eaten in Ethiopia, teff flour is often mixed with other cereal flours, but the flavor and quality of injera made from mixtures is considered less tasty. Injera made entirely from barley, wheat, maize or millet flours is said to have a bitter taste. The degree of sour taste is imparted by the length of the fermentation process. If the dough is fermented for only a short period of time, injera has a tasty sweet flavor.

Disease and Pests

Teff is relatively free of plant diseases when compared to other cereal crops. In Ethiopia, in locales where humidity is high, rusts and head smuts are important diseases. In Ethiopia, 22 fungi and 3 pathogenic nematodes have been identified on teff. Teff seedlings are also susceptible to damping-off caused when sown too early. Since teff has been limited to small areas in the United States few disease and insect problems have been observed. However, a serious problem was observed in South Dakota where the stem boring wasp reduced forage yields by over 70%. The insect problem was observed in only one out of the five years in research trials, the significant losses obtained could be a deterrent to commercial expansion of teff production.

Cultivars

A detailed description of 34 named Ethiopian teff cultivars based on morphological characteristics was published in 1975. The cultivars are described by differences in culms, panicles, panicle branches, leaves, flowers, spikelets, and grains. Studies on teff production in Montana were initiated by evaluating over 300 accessions, subsequently reduced to 12 for further study .

Attempts to develop methods to improve breeding of teff cultivars (which are self-pollinating) have met with only limited success. While teff production in Ethiopia occupies large areas and is the most important staple of the country, most cultivars are selections that have been grown for thousands of years. Although cultivar development has been given a high research priority most on going studies have focused on agronomic practices.

HEALTH BENEFITS

A health related benefit of teff is the high fiber content of the grain. This is particularly important in dealing with diabetes and assisting with blood sugar control. Related to its small size, the grain cannot be separated into germ, bran and endosperm to create a variety of other products. Although this creates some disadvantages for the grain, it allows teff to yield a much higher fiber content than other grains *(15.3 grams of fiber/4 oz flour*, second only t o dark rye flour).

Not long ago it was discovered that Teff is naturally gluten free. Two percent of the West-European people have a lesser or greater intolerance for gluten. Gluten exists in grain like wheat, spelt, rye, barley and oats. People with intolerance to gluten cannot eat regular bread. Products made of teff flour have proven to be gluten free, healthy and taste full. As whole meal flour Teff contains many essential nutrients. Teff flour has proven to be multi purpose. Not only bread but cakes, tarts, snacks, pancakes etc. can be made successfully. Also it can be used as binders in soups and sauces and is being used as food for athletes

The invention relates to flour of Eragrostis tef and to products comprising this flour. The invention particularly relates to flour of Eragrostis which can well be processed into inter alia gluten-free food products and to methods for preparing these food products.

It has already been known for tens of years that gluten (or similar compounds such as hordeins in barley and secalins in rye) in the food, often coming from flour of wheat, barley, rye, oat and spelt, is not suitable for a large number of people, inter alia for babies in the first months of their lives. Many people develop hypersensitivity, which results in patients with a gluten intolerance, or celiac disease.

Celiac disease and dermatitis herpetiformis (celiac disease of the skin) are caused by a hypersensitivity to gluten. When a celiac disease patient eats or drinks something which has been prepared from or with one or more gluten-containing types of grain or has been in contact therewith,

the mucous membrane of the small intestine is affected. A healthy small intestine has a large number of intestinal villi on the inside which together form an enormous surface for food intake. The intestinal villi of celiac disease patients cannot tolerate gluten-or rather, gliadins and glutenins, the building blocks of gluten. As a result of an immune response initiated by gluten, the intestinal villi are affected. Consequently, not all required nutrients can be taken in by the body. This may cause a deficit of inter alia vitamins, calcium and iron.

In the Netherlands, there are an estimated 75,000 celiac disease patients. Celiac disease can be discovered in people of all ages, but two peaks can be distinguished. The first peak is between the sixth and tenth year, the second between the twentieth and fortieth year. Possibly, the second group already has celiac disease from childhood, but the symptoms do not show more clearly (recognizable) until later.

There is no medicine for gluten intolerance. The only way for a celiac disease patient to prevent or treat symptoms is following a strict diet in which there are no (products of) gluten-containing grains or other crops.

This is the gluten-free diet. The diet is sometimes supplemented for some time with iron tablets and extra vitamins and minerals.

There is wheat starch or wheat flour which has been made gluten-free. This can officially be called gluten-free, but is not 100 percent free of gluten. The content of gluten needs to meet the standard of the Codex Alimentarius. For (wheat) flour made gluten-free, this is 200 parts per million (ppm). However, for some celiac disease patients this is still too much: they have symptoms after eating the flour made gluten-free.

Therefore, these people had better opt for the use of products which are naturally gluten-free. For naturally gluten-free products, the set standard is maximally 20 ppm. However, naturally gluten-free products can be contaminated with gluten from other sources during the processing.

Rice, corn, tapioca, soy, buckwheat, arrowroot, potatoes and chestnuts are known crops which yield gluten-free flour, with which a variety of gluten-free food products can be prepared. Another source for gluten-free flour is Eragrostis tef. This crop has been cultivated for human consumption in mainly Ethiopia and Eritrea for more than 5000 years. In addition, Teff is used more and more often for hay in countries such as South Africa and the United States. Teff flour is traditionally used for preparing injera, a sponge like, gray pancake with a somewhat sour taste. Injera is usually made from a flour mixture consisting of equal parts of Teff flour and wheat flour diluted with water and yeast. The

diluted flour mixture is usually fermented for three to four days before it is baked.

Teff offers an attractive source of (gluten-free) flour. However, it has been found that the preparation of a food product with traditional Teff flour (for instance Teff flour which is mixed with wheat flour for preparing injera) often causes problems. A known problem is the instability of the product, particularly of baked products. In other cases, the product has an unattractive taste and/or structure.

For a good and tasty product, Teff flour with such a falling number needs to be used is unexpected. This is because, for baking bread of wheat flour, the optimal falling number for wheat is between 200 and 250. Conversely, wheat flour with a falling number lower than 120 or higher than 300 is not suitable for processing into (yeast-leavened) a baked product. For instance, with wheat with such high falling numbers, an enzyme preparation (for instance malt flour) is added to the flour to obtain an acceptable product. In contrast with this, Teff flour according to the invention preferably has a falling number which is generally higher than the optimal range of falling numbers of wheat.

The falling number (also called"Hagberg falling number", abbreviated to HFN) of a grain or ground grain is usually determined according to the Hagberg method. This method gives a measure for the activity of the enzyme alpha-amylase. Alpha-amylase degrades starch to sugars (maltose and glucose). The falling number obtained relates to the amount of undigested sugars in the starch. The higher the falling number, the lower the alpha-amylase activity and the fewer digested sugars are present in the grain. In the Hagberg analysis method, usually, exactly 7 grams of starch with a moisture content of 14% are brought into a tube with 25 ml of water. After vigorous shaking, an agitator is brought into the tube and the whole is placed in a boiling water bath. After this, the agitator is moved up and down 55 times, then to be released in the highest position.

Due to its own weight, the agitator falls down through the firmed mixture and the duration thereof, measured with the aid of a second counter (for instance a stopwatch), determines the falling number. The falling number can vary from 61 to 600 seconds.

The traditional Teff flour, which is obtained by grinding the grain directly after the harvest, still causes problems with the processing thereof in baked products, as elaborated upon in the introduction. The invention now demonstrates that the reason for this is that, directly after harvesting, Teff grain of known Teff varieties has too low a falling number (that is, lower than 250) to be processed into an attractive product.

It is generally known that grain goes through an after-ripening process after harvesting, in which the falling number of the grain increases.

The invention provides flour of Eragrostis spp. grain, with the grain having been ground at least 4, preferably at least 5, and more preferably at least 8 weeks after harvesting. Such a period is usually sufficient to obtain grain which has after-ripened sufficiently and has a falling number which meets the above-mentioned conditions. Particularly with larger amounts, in practice, the grain will virtually always be stored for some time before it is processed (ground). Teff can be stored in standard manners used for the storage of grains, for instance in (temperature-controlled) silos or towers or in a different suitable storage room such as a shed or barn. However, flour with a falling number according to the invention does not always need to be obtained by means of after-ripening. For instance, a Teff variety (or mixtures thereof) can be selected or generated whose grain already has a falling number of at least 250 at the moment of harvesting.

For making a gluten-free product, of course, during the process of harvesting, drying, transport, storage, grinding, mixing and packaging, adequate precautions need to be taken to prevent any mixing of Teff grain with non-gluten-free crop/seeds and/or flour. Thus, preferably, equipment and material (harvesting machines, transport means, storage rooms, millstones) are used which do not come into contact with gluten-containing crops. In order to be able to store grain so as to be free from decay, the grain preferably has a moisture content of at most 12%. It is therefore advisable to after-dry Teff grain before storage, preferably for a few days. The Teff grain is preferably stored in a closed storage room free from vermin. During after-ripening of Teff grain in cold areas, the falling number goes from an average of 230 immediately after harvesting, to 260 after four to five weeks to 330 two or three months after harvesting. In warmer areas, the after-ripening effect is different and, starting with an average falling number of 230 immediately after harvesting, a falling number higher than 420 may eventually be achieved.

The invention further provides the insight that traditional Teff flour does not only have a too low or a too high falling number to be processed into a good baking product, but that, in addition, it is usually not ground fine enough. The finer the flour, the better the flour can be baked. Flour according to the invention is preferably ground so fine that an essential part of the flour can pass through a sieve with a pore size of at most 150 microns, preferably at most 120 microns, more preferably at most 100 microns. The grinding of Teff grain to flour according to the invention can be carried out according to standard procedures for the preparation of flour.

Preferably, a so-called pin mill with integrated cooling is used, so that the flour does not burn during grinding. For instance, of flour according to the invention, 0% is blocked by a sieve with a pore size of 250 microns.

Maximally 15% remains behind on a sieve with a pore size of 150 microns and maximally 20% when the pore size is only 100 microns (cumulatively approx 30%). So, minimally 70% of the Teff flour according to the invention passes a sieve with a pore size of 100 microns. Such fine flour has been found to be particularly suitable for processing into a baking product.

Without wishing to be bound to any theory, it is conceivable that the good baking qualities of such finely ground Teff flour are related to the fact that, due to the fine grinding, a relatively large surface is available for the absorption of water or a different liquid used for the preparation of a dough.

An additional advantage of flour according to the invention resides in the fact that, compared to other starch sources, Eragrostis tef is rich in minerals, such as calcium, zinc, magnesium, iron, phosphor and potassium.

Flour according to the invention preferably contains at least 0.14%, preferably at least 0.15% calcium. Calcium is the most common mineral in our body. It is indispensable to the skeleton: bone contains 99% of the calcium in the body in the form of calcium phosphate and crystals which ensure the strength of the skeleton and the hardness of the teeth. Calcium also plays a role in numerous metabolic functions in the body.

A flour according to the invention contains at least 0. 003% iron, preferably at least 0.004% iron, more preferably at least 0.005% iron. Iron is one of the most important elements in our body, particularly because it is a building block of hemoglobin and myoglobin. Hemoglobin is the red pigment of blood; myoglobin is mainly found in muscles. Hemoglobin is the substance in the blood which binds oxygen and transports it from the lungs to the cells. Further, iron is a component of various enzymes needed for a variety of metabolic processes in our body.

The consumption of food with high iron content does not automatically result in an increase of iron in the body. This is because the intake of iron from food is a complex process and strongly depends on the form in which the iron is present in the food. Vegetable iron (Fe^{2+}) is usually taken in more poorly than animal iron (Fe^{3+}). In addition, the intake of iron is negatively affected by various other substances in our food. These are mainly mineral/metal-binding substances, such as tannins (inter alia in tea and walnuts), phytates (in grains), oxalates (inter alia in

rhubarb), phosphates, caffeine (in coffee), polyphenols (in fruit), soy proteins, egg albumin and casein (in milk) which reduce the intake of iron from food.

Flour according to the invention surprisingly contains relatively few if any of such mineral-binding substances. Hence, the invention provides flour which is suitable for preparing food, with the flour containing at most 0. 8%, preferably at most 0. 3%, more preferably at most 0.2% of a mineral-binding substance. Thus, compared to flours of frequently used other grains, a flour according to the invention contains only little (0.1 to 0.75%) phytic acid (myo-inositol hexa-kis-phosphate). Studies have shown that anemia hardly occurs in populations where Teff is an important part of the diet: Breeding, genetic resources, agronomy, utilization and role in Ethiopian agriculture, IAR, Addis Abeba, Ethiopia, 1993). The study found that the hemoglobin content of the blood of Ethiopian people who eat Teff was higher than that of non-Teff eaters. This is in all probability due to the high content of available iron in Teff.

In a preferred embodiment of the invention, at least two batches of different lots of Teff with different falling numbers are mixed and ground to obtain a flour with falling number in the optimal range, for instance with a falling number of at least 380-390 for preparing a backed product in accordance with the ‘market standard'. The grain is preferably mixed such that it comprises different after-ripening stages, while, with material which has after-ripened for a long time, some addition of material which has after-ripened for a short time results in a better baking quality. Flour according to the invention can be obtained by grinding a mixture of grains, such as a mixture comprising Teff grains coming from different Eragrostis varieties. A mixture preferably comprises grains with different falling numbers. A grain mixture according to the invention preferably consists for 5-99% of a grain with a falling number higher than 400, more preferably higher than 420, most preferably higher than 450. For the remaining part, such a flour mixture may consist of a grain with a falling number lower than 400, preferably lower than 350. It has been found that flour mixtures comprising flour with a high falling number (approx 450-500) and a relatively low falling number (approx 300-350) have very good baking qualities. Thus, of a Teff mixture according to the invention consisting of approx 20% flour with falling number 450 and approx 80% flour with falling number 320, a bread can be baked which has risen and has been cooked well and has a flexible and elastic structure. The mixing of flours has a favorable effect on the stability of the flour and on the taste of the product (for instance bread) into which the flour mixture has been processed. The invention also provides flour which has a stable falling number of at least 250, preferably at least 300, more preferably at least 340, most preferably at least 380 for a minimum of 3 weeks.

Further, flour according to the invention may consist of a mixture of Teff flour according to the invention and flour of a different gluten-free crop or grain, such as potato, rice, corn, arrowroot, buckwheat or quinoa. A mixture can be obtained by grinding a grain mixture or by mixing flours of different, already ground grains or crops. This flour mixture can preferably be used for preparing (gluten-free) products. Further, flour according to the invention can consist of a mixture of Teff flour according to the invention and mixture of a gluten-containing grain, such as for instance wheat, barley, rye or oat. A mixture according to the invention can consist of flour of two, three, four, five or even more than five different (gluten-free or gluten-containing) grains or crops. The invention further provides the use of a flour or a mixture of flour (baking mix) according to the invention, for instance for preparing a dough or a batter. The invention provides dough or batter and use of dough or batter comprising Teff flour or a flour (mixture) according to the invention, characterized in that the falling number of the Teff grain at the moment of grinding is at least 250, preferably at least 300, more preferably at least 340, most preferably at least 380. Preferably, the falling number of the Teff grain at the moment of grinding is at least 1.01, preferably at least 1.05, more preferably at least 1.20 or even 1.30 times higher than at the moment of harvesting the grain. Very suitable flour (mixture) according to the invention has a falling number between 400 and 550 since these results in a dough or batter with very good baking qualities. Preferably, such a flour (mixture) consists of very finely ground grain kernels (e. g. >50% with a kernel size of maximally 100 microns) since this also has a positive effect on the baking qualities. Batter is a mixture of flour and liquid. Dough is a kneaded mixture of flour and a liquid, such as water, milk, beer or (olive) oil, and optionally other ingredients such as eggs, a leavening agent (such as yeast or baking powder) and a flavoring, such as salt. The mixture can be kneaded both manually and mechanically.

Dough according to the invention comprises dough for the preparation of a wide range of (baked) food such as bread, pastry, cookies, pizza, pasta, noodles, etc. The invention also provides risen dough comprising flour according to the invention. For this purpose, a mixture comprising flour according to the invention, a liquid and a leavening agent is kneaded to dough according to the invention. Then, the dough is stored for some time under conditions which are favorable to rising, for instance in a draft-free, warm place. It has been found in practice that the amount of liquid which needs to be added to Teff flour in order to eventually obtain a good baking product is larger than normally used with different grains or flours. The processing of Teff will involve batter rather than dough.

Gluten-free dough according to the invention can be prepared from the Teff flour described hereinabove. A mixture of this Teff flour and flour of

one or more other gluten-free crops, such as a mixture of Teff flour and buckwheat flour, rice flour, potato flour, arrowroot flour and/or corn flour is also suitable. The invention thus provides flour which is gluten-free and which meets the demands on flour products of the modern western consumer. These products are suitable for all consumers and particularly for people with gluten intolerance. Such products contain less than 20 ppm, preferably less than 5 ppm, more preferably at most 1 ppm of gluten.

In addition, the invention provides a method for baking a product comprising the steps of : a) preparing a dough or batter by mixing a flour according to the invention with a liquid (for instance water, milk, beer or oil) and optionally a leavening agent; b) kneading this dough in a desired shape and c) heating the dough for some time.

With the use of a gluten-free flour according to the invention, and if, during preparation, contamination with a gluten-containing product is prevented, the invention further provides a method for baking a gluten-free product.

The invention provides a food product or a luxury food product comprising a flour according to the invention. A food product or luxury food product according to the invention may be both gluten-free and gluten-containing. The Teff flour component in such a flour comprises preferably at least 0.005% iron, at least 0.14% calcium, and at most 0. 8% mineral (iron) -binding substances. The eventual concentration of these substances will depend on the amount of Teff flour used relative to the other components used. The food product or luxury food product may have a solid or a liquid form.

A food product according to the invention is, for instance, a baked product prepared according to a method of the invention, such as bread, pastry, cookies, crackers, biscuit, food bars, cornflakes, breadcrumbs, or a drink prepared from flour according to the invention. A food product or luxury food product according to the invention may also be prepared from ungrounded grain belonging to the genus Eragrostis, preferably Eragrostis tef, characterized in that the falling number of the grain is at least 250, preferably at least 300, more preferably at least 340, most preferably at least 380. Such grain can be obtained by letting the grain after-ripen. An example of such a product is a (n) (alcoholic) drink such as beer prepared from Teff grain with a falling number of at least 250. Depending on the food application of the grain, grain with a particular falling number can be chosen.

Other examples are extruded products or dry dough products comprising dough according to the invention, for instance pastas (for instance

macaroni, spaghetti, tagliatelle, lasagna, etc.) and noodles
 (vermicelli, thin Chinese noodles, chow mien, etc.). Due to the specific character of the Teff starches (it contains a large proportion of starch which is slowly digestible), the flour or a food product according to the invention is excellently suitable for the stimulation of the natural and thus desired flora in particularly the large intestine.

The invention further provides a pre-baked product comprising a flour according to the invention, such as pre-baked bread which can be baked off at home by the consumer. This pre-baked product is usually marketed as a (deep-) frozen product.

An advantage of food comprising a flour according to the invention is that Teff contains relatively high contents of health-promoting nutrients compared to other grains, such as wheat, barley and millet. This is inter alia due to the fact that the proportion of germ and brans in Teff grain is relatively large. For grains, carbohydrates form the most prominent component in the food. Sports nutrition consists preferably at least for 60% of carbohydrates in the form of glucose (this is because they are most easily converted into energy). Carbohydrate sources can be categorized on the basis of their Glycemic Index (GI). The GI expresses itself in the elevation of the blood sugar level with a predetermined amount of a particular food product. Food products reach a GI reaction value of between 0 and 100, where white bread with a GI of 70 is used as a reference. Food products with a long absorption time (lower intake rate) are called 'low GI' food products (low GI means a GI lower than 55). Food products with a GI which is higher than 70 are called 'high GI'food products according to this method. For sportspeople, food with a high GI is, on the one hand, attractive, since it quickly results in available glucose. On the other hand, this initial elevation stimulates the secretion of insulin, so that the glucose level also quickly drops again. This problem is particularly known after eating pasta products, a source of carbohydrates which is very popular with sportspeople.

An unexpected advantage of food prepared from Teff flour according to the invention is that, although this food has a high GI, the glucose level remains high. These favorable properties of after-ripened Teff flour according to the invention are possibly the result of the relative proportions of free sugars and undigested sugars (starch) in Teff. It has been found that approx 20% (10-30%) of the carbohydrates in Teff belong to the rapidly degradable type, so that an initially high blood sugar level is obtained.

However, about half (35-65%) of the carbohydrates belong to the slowly degradable type, causing a prolonged, constant conversion from starch into glucose. In this manner, the invention hence provides a food (such

as pasta or a sports bar) which is very suitable for people, such as (endurance) sportspeople, who have a quick and prolonged need for carbohydrates. Such products are also referred to as" slow release energy" products. Such a food is also excellently suitable for people with overweight problems who want to control their weight by postponing the appetite. The invention also provides a food or luxury food containing Teff flour according to the invention which, inter alia thanks to the low content of mineral-binding substances and the 'slow carbohydrates' in Teff, has a positive effect on health. For instance, a food according to the invention has a positive effect on the prevention or treatment of (the symptoms of) anemia, diabetes and obesity. Particularly patients who suffer from diabetes type II have a need for slowly, gradually releasing carbohydrates/glucose.

The remaining amount of carbohydrates in Teff flour (approx 20-40%) is referred to as 'resistant' carbohydrates, because they are not converted into glucose by the digestive system. However, it has been found that these resistant carbohydrates are used as a food by microorganisms present in the intestine (intestinal flora), so that consuming products prepared from Teff flour has a favorable effect on the composition and vitality of the intestinal flora, such as it is, for instance, also obtained by consuming probiotics.

The above-mentioned percentages of the different types of carbohydrates in Teff flour are only indications, and the eventual content in products prepared with Teff flour will depend on the type of flour (which Teff varieties the grain comes from, how long it has after-ripened), whether mixtures of flours (with different Teff flour, with different gluten-free or gluten-containing flour) have been used and how the preparation of the product has taken place (baking time, temperature, additives).

The flour according to the invention, or the starch obtained there from, may also be used for different other applications. This is because the invention further provides a coating comprising flour according to the invention and food products which are at least partly provided with such a (n) (edible) coating, such as for instance cheese, French fries or peanuts.

In a further embodiment of the invention, a method is provided for binding a composition of at least two components, comprising the step of mixing these components with starch according to the invention. In relation to food, such thickening agents may, for instance, be used in soups and sauces. However, such a composition may also be used as a binding agent in a pharmaceutical composition such as a tablet, a capsule or a coated tablet.

It is known that some medicines with binding agents based on gluten-containing starch cause problems for some celiac disease patients. By using starch of a gluten-free flour according to the invention (Teff flour optionally mixed with a different gluten-free flour), a method is now provided to obtain a composition which is also suitable for persons with a gluten intolerance. Also, such a starch can be used with advantage for binding a cosmetic composition, such as a facial powder.

In summary, it can be stated that the products and methods of the invention make it possible to provide food products with an eating value (taste, smell, texture, structure) acceptable in the western world which can be used as functional food. Particularly important are: a) the gluten-free aspect, so that celiac disease patients have a whole new range of food products at their disposal; b) the unique composition of the carbohydrates, so that the food products are excellently suitable as food for diabetes type II patients, endurance sportspeople and as diet food (postponing appetite); c) the relatively large amount of 'resistant carbohydrates', so that the food products stimulate the intestinal flora; d) the great amount of iron and the virtual absence of mineral-binding substances, so that anemia is prevented; and e) the large amount of free minerals, such as Ca, Mg, Mn and K, which help with the rapid recovery of the body after a great physical achievement.

The standard baking test of Teff bread was carried out as follows, where the Teff flour was ground fine in a pin mill until minimally 70% of the Teff flour passed a sieve with a pore size of 100 microns: Recipe : INGREDIENTS WEIGHT PERCENTAGES IN GRAMS Teff flour 100. 00 500. 00 Citric acid 0. 20 1. 00 Chicken egg white powder 4. 50 22. 50 Water (30°C) 110. 00 550. 00 Yeast 6. 00 30. 00 Method: Mix dry components Combine water and yeast in basin Add dry components to water/yeast mixture Make batter in beating machine Beat for two minutes in lowest acceleration Beat for approx three minutes in high acceleration Scoop batter into two cake tins of 450 grams Let batter rise to edge of cake tin Bake in oven of approx 235°C for approx 20 minutes . Remove and cool Assessment of baking product: Each dough/bread was assessed for color, batter firmness, rising speed, rising height, oven rise, baking nature, bread height, bread structure, smell and taste. The assessment is a weighed average on a scale of 1 to 10.

Recipes

Recipes for injera and other baking and cooking uses for teff have been included in "The Splendid Grain" cookbook. (R. Wood 1997). The following recipes were included in the teff grain packages marketed by

Arrowhead Mills, Herford, Texas. Arrowhead Mills no longer markets teff, however they have extended the courtesy to allow the publication of their recipe brochure.

Teff is a very versatile seed. Uncooked Teff can be added to most kinds of baked goods or substituted for part of the seeds, nuts, or small grains. Because of its small size and high density, use less Teff than the amount of other grain or seed for which it is substituted. One half cup Teff can be used to replace 1 cup of sesame seeds. Cooked Teff is gelatinous and adds body to puddings and icebox pies. It is a good thickener for soups, stews, and gravies. Its mild, slightly molasses-like sweetness makes Teff easy to include. Use the ideas in these recipes to include Teff in many of your favorite breads, biscuits, cookies, cakes, stir fry dishes, casseroles, soups, stews, and puddings.

To cook teff place 2 cups of purified water, ½ cup teff and a ¼ teaspoon of sea salt in a saucepan. Bring to a boil, reduce heat and simmer covered for 15 to 20 minutes or until the water is absorbed. Remove from heat and let it stand covered for 5 minutes. Cook teff can be mixed with herbs, beans tofu, garlic and onions to make grain burgers. The seeds can also be sprouted and the sprouts used in salads and on sandwiches.

Pancakes

1 cup cooked Teff
1/4 tsp. sea salt
1 cup Arrowhead Mills Multigrain Pancake Mix
1 cup water or enough to make pancake batter
1 egg (optional)
1 tbsp. Oil (optional)

Mix all ingredients. Cook on a hot, oiled griddle.
Serve with your favorite syrup.

Hush Puppies

1/2 cup Yellow Cornmeal
1/2 cup Unbleached White Flour
2 tbsp. uncooked Teff
1/2 tsp. sea salt
1/2 tsp. garlic powder
1/2 tsp. low sodium baking powder
pinch pepper

1 egg, beaten
1/4 cup water
1 tbsp. Olive Oil
1 tbsp. honey

Combine all ingredients. Drop by the teaspoonful and deep fry in hot oil.

Teff-Carob Cookies

3/4 cup Rice Flour
1/4 cup Barley Flour
1-1/2 tbsp. carob powder
1/4 cup uncooked Teff
1/4 cup molasses or maple syrup
1/2 cup water or milk
1/4 tsp. almond extract

Mix dry ingredients. Mix liquids. Combine mixtures. Drop small spoonfuls onto oiled baking sheet. Bake at 350□F for 8-10 minutes.

Teff Oat Bran Muffins

1/2 cup Arrowhead Teff
1/4 cup boiling water
2 cup Arrowhead Whole Wheat Pastry Flour
1/2 cup Arrowhead Oat Bran
1-1/2 tsp. baking soda
1/2 tsp. salt (optional)
1/2 cup honey
2 tbsp. Arrowhead Sesame Oil
1 cup buttermilk
1 egg, slightly beaten
1 tbsp. grated orange rind

Preheat oven to 375□F. Oil muffin tin. In a mixing bowl, pour boiling water over Teff. Stir to moisten all Teff. Set aside. In another mixing bowl mix flour, Oat Bran, baking soda, and salt. When the Teff mixture is cool, stir in honey, oil, buttermilk, egg, and grated orange rind. Add to dry ingredients. Mix with a few quick strokes, spoon into prepared muffin tin and immediately place into preheated oven. Bake for 20 minutes. Cool for 10 minutes before removing from tin. Makes 12 muffins.

Pudding

1 cup cooked and cooled Teff (cooked like cereal omitting raisins)
1 cup tofu

2 to 4 tbsp. maple syrup, honey, or other syrup
1 tsp. vanilla

In a blender combine tofu, sweetener, and vanilla. Blend until smooth and light. Pour cooked Teff and tofu mixture in a bowl. Mix thoroughly, cover, and chill

Variation: Add slices bananas. Serve over Teff-Carob Cookies.

Teff-Peanut Butter Muffins

1/3 to 1/2 cup uncooked Teff
2 cups Whole Wheat Pastry Flour
1 tbsp. low-sodium baking powder
1/2 tsp. sea salt
1/4 cup Peanut Butter, Crunchy or Creamy
2 tbsp. Unrefined Safflower Oil
1-1/2 cups water
4 tbsp. molasses, honey, or maple syrup

Stir Teff, flour, baking powder, and salt together. Cut in Peanut Butter and oil with fork or pastry blender until the mixture is like crumbs. Add the water and molasses; stir just until well mixed, but do not beat. Fill oiled muffin cups 2/3 full. Bake 12-15 minutes at 350□F or until done.

Teff Burger

1 cup Arrowhead Teff
3 cup water
1 tsp. thyme
2 cloves of garlic, minced
1/4 tsp. salt (optional)
3 scallions, chopped
2 tbsp. Arrowhead Sesame Oil
6 slices Jarlsberg Cheese
6 slices tomato
6 lettuce leaves
6 hamburger buns

Place Teff, water, thyme, garlic, and salt in a pan and bring to a boil. Cover and simmer for 15 minutes. Stir once or twice toward the end of cooking. Spread cooked Teff in a shallow pan to cool. When cooled, add scallions and form patties. Heat a skillet, add oil, and fry until nicely browned. Turn, top with cheese and cook until the bottom is browned and the cheese is melted.

Assemble burgers on buns with lettuce and tomato.
Makes 6 burgers.

Menus and Recipes from Africa

Ethiopia

This ancient country, old even before the time of Christ, is called the land of thirteen months of sunshine, (the Ethiopian calendar having twelve months of thirty days and an extra month of five days called Pagume). The climate is balmy and pleasant with rain falling rarely except in the summer months.

Here, where the Queen of Sheba once ruled, primitive and modern cultures exist side by side. In the villages, families live in "tukels" made of stone with thatched roofs, and life goes on today much as it has for centuries. In Addis Ababa, there are new white buildings of reinforced concrete in the midst of bustling, energetic people. Women with exquisite facial bone structure wear shamas, a gauzelike white fabric covering them from head to foot. Men wear either Ethiopian robes or Western dress.

The open-air market of Addis is the largest and most exciting in all of Africa. The market seems to stretch for miles. Everything is on display, from clothing and household wares to treadle sewing machines. And the food! Women sit cross-legged on the ground with tiny scales to measure spices for the Wat-the stews cooked in every home. Grains, called Tef, in huge bags are ready for the housewives who make Injera--the unleavened bread prepared today as it was a thousand years ago. The low stands are heaped with citrus fruits, bananas, grapes, pomegranates, figs, custard apples (a delectable tropical fruit), and vegetables of all kinds, including the wonderful red onion of this area and Gommen, a kale-like plant used in the Alechi: the stews of the fast days. The meats on sale are beef, lamb, and goat. You'll find a sort of rancid butter cut from a large block and sold in chunks wrapped in wax paper, along with lab, a soft cheese wrapped and kept cool in banana leaves.

The Coptic Church, the dominant religious sect in Ethiopia since the fourth century, dictates many food customs. There are fast days when meat is prohibited and pulses-lentils, peas, field peas, chick peas, and peanuts-are used in making the Wat and Alechi. No one is permitted to eat pork. The hand washing ceremony before and after meals is a religious ritual. Even the manner in which meats are prepared is dictated. The hottest, most peppery food in all of Africa is found in Ethiopia. The foreigner, not accustomed to the hot spice Ber-beri or Awaze, specially prepared with red pepper and containing as many as

fifteen spices, cannot take it. But if you cut down on the pepper, you will find the food to be as interesting and exciting as anything you have ever eaten.

How a Dinner is Served in Ethiopia

A meal in Ethiopia is an experience. When you have dinner in an Ethiopian home or restaurant, you eat the tablecloth!

One or two of the guests are seated on a low comfortable divan and a mesab, a handmade wicker hourglass-shaped table with a designed domed cover is set before them. The other guests are then seated round the table on stools about eight inches high covered with monkey fur.

A tall, stunning woman with characteristically high cheekbones and soft skin, dressed in a shama, carries a long-spouted copper ewer or pitcher in her right hand, a copper basin (which looks like a spittoon) in her left hand, and a towel over her left arm. She pours warm water over the fingers of your right hand, holding the basin to catch the excess, and you wipe your hands on the towel that hangs over her arm.

The mesab is taken out of the room and returned shortly with the domed cover. She removes the dome and the table is covered with what looks like a gray cloth overlapping the edge of a huge tray. But it is not a "tablecloth" at all. It is the Injera, the sourdough pancake-like bread of Ethiopia. Food is brought to the table in enamel bowls and portioned out on the "tablecloth!" When the entire Injera is covered with an assortment of stews, etc., you tear off a piece about two or three inches square and use this to "roll" the food in-the same way you would roll a huge cigarette. Then just swoop it up and pop it into your mouth. Your host might "pop" the first little "roll" in your mouth for you. It takes a bit of doing to accomplish this feat but once you master it, you cannot help enjoy It.

Our server returns with individual long-necked bottles from which you drink Tej, an amber-colored honey wine. It is put on a little table close by. Or she may bring a weakly carbonated water or Tella, the homemade beer.

You learn that you are eating Chicken Wat and Lamb Wat-two peppery stews- Iab-cottage cheese and yogurt with special herbs giving it an acidic lemon flavor; and Kitfo-ground raw beef, which we are told is considered the dessert of the meal.

No other dessert is served. Coffee comes in on a tray in tiny Japanese cups served black with sugar.

Dinner is concluded with hand-washing again and incense is burned.

recipe:

Ethiopian Injera

Injera is not only a kind of bread—it's also an eating utensil.

In Ethiopia and Eritrea, this spongy, sour flatbread is used to scoop up meat and vegetable stews. *Injera* also lines the tray on which the stews are served, soaking up their juices as the meal progresses. When this edible tablecloth is eaten, the meal is officially over.

Injera is made with *teff,* a tiny, round grain that flourishes in the highlands of Ethiopia. While teff is very nutritious, it contains practically no gluten. This makes teff ill-suited for making raised bread, however *injera* still takes advantage of the special properties of yeast. A short period of fermentation gives it an airy, bubbly texture, and also a slightly sour taste.

Ethiopian and Eritrean immigrants have modified their recipes after moving to the United States or Europe, depending on what grains are available to them. The *injera* you find in many East African restaurants in the United States includes both teff and wheat flours. Most *injera* made in Ethiopia and Eritrea, on the other hand, is made solely with teff.

Injera

Depending on where you live, teff flour can be difficult to come by. Try a well-stocked health food store, or look online.

What Do I Need?

- 1/4 cup teff flour
- 3/4 cup all-purpose flour
- 1 cup water
- a pinch of salt
- peanut or vegetable oil

Teff grain

• a mixing bowl
• a nonstick pan or cast-iron skillet

Tip
If you have teff grain instead of flour, first grind it in a clean coffee grinder, or with a mortar and pestle.

What Do I Do?

1. Put the teff flour in the bottom of a mixing bowl, and sift in the all-purpose flour.

2. Slowly add the water, stirring to avoid lumps.

3. Stir in the salt.

4. Heat a nonstick pan or lightly oiled cast-iron skillet until a water drop dances on the surface. Make sure the surface of the pan is smooth: Otherwise, your *injera* might fall apart when you try to remove it.

5. Coat the pan with a thin layer of batter. *Injera* should be thicker than a crêpe, but not as thick as a traditional pancake. It will rise slightly when it heats.

6. Cook until holes appear on the surface of the bread. Once the surface is dry, remove the bread from the pan and let it cool.

If you've ever cooked pancakes, making *injera* might seem familiar. In both cases, tiny bubbles form on top as the batter cooks. Keeping an eye on these bubbles is a great way to see how close the pancake or *injera* is to being ready without peeking underneath.

These bubbles come from the carbon-dioxide produced by the leavener—usually baking powder or soda in the case of pancakes, "wild" yeast in the case of *injera*. Neither batter contains much gluten. Most pancake recipes tell you not to mix the batter too much: If you do, gluten will develop, making them too chewy. Teff, the grain used to make *injera*, contains very little gluten to begin with. In both cases, the result is the

same: With no gummy substance to “blow up,” most of the carbon-dioxide from the leaveners rapidly escapes into the air, leaving the little popped bubbles that contribute to the distinctive textures of these breads.

FUTURE PROSPECTS

While teff has survived for thousands of years as a major food staple for humans and as fodder for cattle, there are some negative aspects to the nutritional value of injera. Research studies have shown that if the fermentation process is prolonged to produce the sour type of injera, essential nutrients particularly amino acids such as lysine are lost in the liquid which is removed from the dough. The nutrient loss can be reduced if the fermentation process is shortened but then the result is a sweet type of injera, which does not store as well as the sour type. Tabita is also a fermented teff flour pancake which is easily digestible and non-bitter (Anon. 1897). We do not known if the tabita bread is another name for injera.

The major advantages of teff production in Ethiopia according to Ketema (1987) are as follows:

- It can be grown under moisture-stress areas.
- It can be grown under waterlogged conditions.
- It is suitable and is used for double and relay cropping.
- Its straw is a valuable animal feed during the dry season when there is acute shortage of feed. It is highly preferred by cattle and costs higher than the straw of other cereals.
- It has acceptance in the national diet and enables farmers to earn more because of its high price.
- It is a reliable and low-risk crop.
- It is useful as rescue or catch crop in moisture-stress areas. For example, around Kobo or Zeway, farmers first plant maize around April. If the crop fails due to moisture stress, they plow it under and plant sorghum. If this one also fails, it is again plowed under and as a last resort farmers sow teff. In some areas teff is sown because farmers cannot grow wheat, maize, or sorghum due to moisture stress. However, this practice is not widespread, and farmers should be encouraged to reserve teff for use if crops of other cereals fail, especially in drought-prone areas.

- It can be stored easily under local storage conditions since it is not attacked by the weevil and other storage pests, thus reducing postharvest management costs.
- It can be stored for a relatively long period of time (a minimum of 3 years) before it loses its viability. It can be stored in moisture-stress areas where more than one sowing in one season is a common practice or where the rains can fail for more than one year. If it is required for food, it can also be stored for more than 5 years, and perhaps indefinitely.
- It has less disease and pest problems than any other cereal.

CONCLUSION

Present day production and use of *Erogrostis tef* (Zucc.) Trotter, which means "lost" in Amharic, for grain or fodder in the United States represents re-discovery of a crop used by ancient civilizations. Teff is a C_4 plant, having Kranz anatomical characteristics, and is intermediate between a tropical and temperate grass. The use of teff can be traced back to about 3359 BC. In contrast to amaranth, which was utilized by early civilizations throughout the world, teff production and uses have been primarily restricted to the countries of Ethiopia, India and its colonies, and Australia (Anon. 1894). While teff grain still provides over two-thirds of the human nutrition in Ethiopia, it is relatively unknown as a food crop elsewhere. Teff has adaptive characteristics similar to other crops grown by early civilizations. Teff can be cultivated under a wide range of environmental conditions such as on marginal soils under water logged to drought conditions. Teff can produce a crop in a relative short growing season and will produce both grain for human food and fodder for cattle. The grain is either white or a very deep reddish brown in color. Published accounts of teff in the late 1800s report that upper class consumed the white grain, the dark grain was the food of soldiers and servants, while hay made from teff was consumed by bullocks. Late 20th century publications in the United States describes teff grain as being marketed as a health food product, or used as a late planted emergency forage for livestock .

Domestic experience in teff production is limited; however, teff grain has already found a niche as grain and flour in the health food market. The future of teff forage production for livestock in the United States is unknown. Teff does have the advantage of producing a good hay or pasture crop when late season plantings are required due to a crop failure. Results of a nationwide survey indicate that this crop is virtually unknown in most states, and that production may be limited to only a few western states. Information on teff production in the United States remains scarce as most teff production is handled by private entrepreneurs.

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