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Review Article

The Study of Some Particle Size Distribution of Teff [*Eragrostis teff* (Zucc.) Trotter] Grain Cultivars and Its Flour

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Abstract: Teff is one of the major and indigenous cereal crops in Ethiopia. It is a unique durable crop grown over a wide range of environmental conditions in Ethiopia and has been utilized as food and supplements for majority of the human diet in Ethiopia. The results were reported as an average value of triplicate analysis of (mean ± SD) and were analyzed by Fisher's Least Significance Difference (LSD) method and at statistical significance of $P<0.05$. This study was conducted to generate information in different teff grain flour on some particle size distributionof teff [Eragrostisteff (Zucc.) Trotter] grain cultivars and its flour. Six teff varieties namely Quncho (DZ-Cr-387), Felagot (DZ-Cr-442), Tesfa (DZ-Cr-457), Kora (DZ-Cr-438), Dukem (DZ-Cr-425) and Dagme (DZ-Cr-43B varieties) were considered and their selection was based on their recent year coverage area and the expected future expansion. The grain particle size distribution showed that varieties differ in grain size and showed the size range which would be helpful in design of screens for cleaning of the grains. Each variety was studied for particle size distribution of teff grains cultivars and the flours. The particle size distribution of teff grain cultivars and its flour showed significant ($P<0.05$) differences among the varieties. There were significant ($P<0.05$) differences among the varieties except dough stability time.

Keywords: *Particle* Size, *Size* and Sieve Analysis, Teff

1. Introduction

Teff [*Eragrostistef* (Zucc.) Trotter] is traditionally processed at house hold level and consumed as *injera* (fermented flatbread), sweet unleavened bread, local beverage porridges and soup. Recently tef is attracting the attention of the modern food industry since it is a gluten-free grain encompassing highly appreciated nutritional advantages. As *teff* is relatively a new raw material for the modern food industry and it is consumed as whole grain, studies should be conducted to determine its powder behavior during storage, handling and processing. Powder flow properties are vital in different unit operations, such as flow from hoppers and silos, transportation, mixing, compression and packaging. The powder flow and packing characteristics are often investigated by calculating indices which help to characterize them via measuring handling angles, tap testing, shear cell measurements, etc [1].

Teff cultivars have been distinguished and described based on the color of the grains and inflorescences, ramification of the inflorescences and the size of plants [2]. In Ethiopia DebreZeit Agricultural Research Center (DAZRC) is the center of excellence for tef research within the Ethiopian Agricultural Research Institute (EIAR). From 1970-2011 from tef breeding national research centers 31 tef varieties were released. On experimental station, the yields of these varieties are in the range of 15 to 34 quintals per hectare and on farm level the range was 14 to 20 quintals per hectare [3]. Effect of the mill type utilized/flour granulation on the flour physical and techno functional characteristics and starch hydrolysis has not been reported yet. Therefore, this study tried to address this gap by studying impact of variety type mill type on: i) flour particle size distribution, density and color, ii) grain flour structure and starch damage, iii) flour techno-functional properties, iv) *in vitro* starch digestibility, and (V) proteins characterization by assessing their molecular weight distribution for three grain tef varieties were studied.

2. Literature Review

Particle size or sieve analysis is a practice or procedure commonly used in engineering to assess the particle size distribution of a granular material. The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of grain flour wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common [4]. The particle size of starch is one of the most important characteristics, which may influenced other physicochemical properties such as swelling power, flour flowability and water-binding capacity [5]. The particle size distribution of sweet potato flours was found to be of bipolar curve shape at mean diameter and also an additional peak at small particle diameters. This bipolar distribution result is similar with the sweet potato flours reported by [6] where the presence of the smaller peak at a smaller particle size is due to the isolated starch granules that probably arise due to the increase of powder extraction rate during milling. Particle size is one of the most important physical properties which affect the flow ability of powders. It is generally considered that powders with particle sizes larger than 200 μm are free flowing, while fine powders are subject to cohesion and their flow ability is more difficult. Particle size distribution is an important characteristic contributing to product appearance. Particle size affects the overall bulk properties of the food item such as visual texture and density as well as color. [7] Cited that larger particle size may indicate a chewy food, whereas smaller particle size may indicate crunchy. Different milling or grinding processes have been shown to produce different flours with different particle size and degree of damage of starch granules in flour, depending on the mechanical forces and temperature during the grinding process [8]. The kinetics of starch digestion by alpha amylase of barley and sorghum flours was found to be dependent on the particle size of flours [9]. Starch damage encompasses disruption of the granular structure (Level 5) of the starch [10], the extent being dependent on the starch size, botanical source and milling condition [11]. The extent of starch damage is known to affect the quality and functionality of the flours. In Ethiopia tef is mainly processed to *injera*after milling with disc attrition mills available in cottage grain mill houses. *Injera*with much and evenly spread eyes, soft texture, easily roll able and bland after taste is rated as excellent. Intrinsic tef flour quality factors which favor these quality aspects include starch granule characteristics and the higher water solubility index of tef flour which positively influence *injera* quality [12].

3. Materials and Methods

3.1. Experimental Sit

The experiments were conducted at Hawssa, Haramaya and Addis Ababa Universities. The experiments like determination of physical properties of *teff* grain and its flour were conducted at Hawssa University, functional properties of *teff* flours was carried out at Haramaya University in Food Science and Technology Laboratories,

3.2. Experimental Material

The six-*teff* varieties of Quncho (DZ-Cr-387), Felagot (DZ-Cr-442), Tesfa (DZ-Cr-457), Kora (DZ-Cr-438), Dukem (DZ-Cr-425) and Dagme (DZ-Cr-43B) were obtained from DebreZeit Agricultural Research Center of the Ethiopian Institute of Agricultural Research (EIAR).

3.3. Preparation of Sample

The different *teff* grains varieties were cleaned manually by sifting and winnowing and separating from chaffs, dust and other impurities. Then they were ground into fine flour by using disc mill (attrition mill) and the flour was sifted to pass through 710μm sieve [13]. It was then place in sealed polyethylene plastic bags, and stored at room temperature for further laboratory analysis.

3.4. Producer of Particle Size Distribution and It Size

3.4.1. Particle Size Distribution

The *teff* grain samples of 600g were sieved for 5 min with the help of a test sieve shaker (Wykeham France Engineering Ltd., England) through a range of sieves for *teff* grain 1000, 710, 500, 300 & 250 microns and *teff* flour 710, 500, 250, 180, 125 microns connected in tandem with the largest size on the top. Grain mass was determined after measuring the sample retained on each test sieve on electronic balance (± 1mg). The weight rating of each size range is calculated as shown below.

$$\%\ \text{Weight ofrecovered} = \frac{\text{weight onsieve}}{\text{total weight}} * 100$$

3.4.2. Size Determination

The length and width of the teff grain sample was determined by using over head projector. The teff grain sample was spread on glass surface overhead projector together with a measuring scale. The light was turned on and the images of the teff grains and of the measuring scale were projected on a screen placed against a wall. The sizes of the images on the screen of both the measuring scale and the teff grains were measured using another scale. The magnification ratio between the size of the units on actual measuring scale on the projector glass surface and those of its image on the screen was determined and was formed to 10. Using the ratio, the actual dimensions of the grains were determined from the dimension readings of the images on the screen, i.e. the length and width of the images of the grains were divided by 10 to get the actual dimensions of the grains.

4. Results and Discussions

Particle Size Distribution

The particle size distributions of the teff varieties flour are presented in Table 1. There were significant ($P<0.05$) differences among the varieties. *Teff* grain sizes are extremely small and the size variations assessed after passing through test sieves of 1000, 710, 500, 300 and 250 µm showed that virtually no grain had remained on the sieves of 1000 microns. The mass retained on 710 microns test sieve ranged from 0.76 to 1.93%. The highestpercentage (1.93%) ofthe larger particle size (710 µm) happened to variety (DZ-Cr-442). On the other hand the lowest percentage (0.76%) of the largest grain size (710 µm) happened to variety DZ-Cr-387. Significant (P<0.05) differences in regard to the properties of the largest grain size (710 µm) happened among the six varieties. In regard to grain size the largest proportion in each variety was the 500 µmsize which varied between 52.61% for DZ-Cr-387 and 55.57% of variety DZ-Cr-442. In this category the majority of the *teff* varieties showed no significant (P>0.05) differences. The next larger proportion in grains size is the 300µmwhich shared between 41.67% and 46.43% of the grains for varieties DZ-Cr-387 and DZ-Cr-442, respectively. In all the varieties, the sizes of 250 µm were less than 1%. Generally it can be seen that the majority of *teff* grains are of sizes of 300 to 500µm [14].

The measured length of the *teff* varieties is presented in Table 1. The values were 1.40, 1.60, 1.70, 1.80, 1.53 and 1.30mm for Quncho (DZ-Cr-387), Felagot (DZ-Cr-442), Tesfa (DZ-Cr-457), Kora (DZ-Cr-438), Dukem (DZ-Cr-425) and Dagme (DZ-Cr- 43B) varieties, respectively. There were significant (P<0.05) differences among the varieties. Dagme (DZ-Cr-43B) having the lowest value 1.30 mm in length and Kora (DZ-Cr-438) had the highest value 1.80mm. The range of grains width (W) value from 0.60 to 0.87mm are presented in Table 1. There were no significant (P>0.05) differencesamong the varieties. The results were found to be within the ranges between 1.70and 1.0mmgrainlength, 0.5 and 1.0mm width reported by Ebba, (1975). On 710 micron, the highest grain length was for DZ-Cr-438 and the grainwidthforDZ-Cr-457 and the lowest grainlength was forDZ-Cr-43Band the grain width for DZ-Cr-438 [15].

Table 1. *Particle size distribution (%) and sizes of teff grain.*

Varieties	250 µm	300 µm	500 µm	710 µm	L (mm)	W (mm)
DZ-Cr-387	$0.20{\pm}0.01^{b}$	$46.43{\pm}0.61^{a}$	$52.61{\pm}0.79^{b}$	$0.76{\pm}0.15^{d}$	$1.40{\pm}0.10^{dc}$	$0.77{\pm}0.10^{a}$
DZ-Cr-442	$0.56{\pm}0.03^{a}$	$41.94{\pm}0.63^{c}$	$55.57{\pm}0.46^{a}$	$1.93{\pm}0.18^{a}$	$1.60{\pm}0.10^{bac}$	$0.80{\pm}0.10^{a}$
DZ-Cr-457	$0.90{\pm}0.22^{a}$	$43.38{\pm}1.14^{b}$	$54.01{\pm}1.49^{ba}$	$1.71{\pm}0.21^{ba}$	$1.70{\pm}0.10^{ba}$	$0.87{\pm}0.05^{a}$
DZ-Cr-438	$0.33{\pm}0.25^{ba}$	$43.47{\pm}0.57^{b}$	$54.91{\pm}0.53^{a}$	$1.29{\pm}0.14^{c}$	$1.80{\pm}0.10^{a}$	$0.60{\pm}0.10^{a}$
DZ-Cr-425	$0.31{\pm}0.21^{ba}$	$43.55{\pm}1.16^{b}$	$54.26{\pm}1.11^{a}$	$1.88{\pm}0.01^{a}$	$1.53{\pm}0.06^{bc}$	$0.86{\pm}0.12^{a}$
DZ-Cr-43B	$0.31{\pm}0.02^{ba}$	$44.16{\pm}0.35^{b}$	$54.09{\pm}0.32^{ba}$	$1.44{\pm}0.16^{bc}$	$1.30{\pm}0.20^{d}$	$0.90{\pm}0.36^{a}$
LSD	0.29	1.43	1.57	0.28	0.21	0.31
CV	5.34	1.83	1.63	10.00	7.58	5.61

Means with different superscript letters in the same column have significant (P<0.05) differences

5. Conclusions

Teff is one of the major and indigenous cereal crops in Ethiopia. It is a unique durable crop grown over a wide range of environmental conditions in Ethiopia and has been utilized as food and supplements for majority of the human diet in Ethiopia. The grain particle size distribution showed that varieties differ in grain size and showed the size range which would be helpful in design of screens for cleaning of the various products. Six *teff* varieties namely Quncho (DZ-Cr-387), Felagot (DZ-Cr-442), Tesfa (DZ-Cr-457), Kora (DZ-Cr-438), Dukem (DZ-Cr-425) and Dagme (DZ-Cr-43B). The results were reported as an average value of triplicate analysis of (mean ± SD) and were analyzed by Fisher's Least Significance Difference (LSD) method and at statistical significance of P<0.05.

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