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Some Physical Properties of Yarma Bulgur

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Abstract: Physical properties often required for the designing of harvesting, transporting, elevating, peeling, drying, calibrating, crashing machineries were determined at dry base moisture content of 12.27% (yarma) and 13.4% (bulgur). The values of average length, width, thickness and geometric mean diameter of yarma were 6.35, 3.32, 2.94 and 3.95 mm. The mean spherity value of yarma was obtained as 0.62. One hundred grain weights of yarma and bulgur grain were 4.36 and 1.02 g, respectively. The mean bulk and true densities were 709, 1258.19 kg m^{-3}, respectively for yarma and were 765, 1444.72 kg m^{-3}, respectively for bulgur. The angle of repose of yarma and bulgur were 14.4° and 16.2°, respectively. The values of coefficient of dynamic friction against galvanized steel, mild steel and plywood surfaces were 0.25, 031 and 0.34, respectively for yarma grain and 0.33, 0.39 and 0.45, respectively for bulgur grain; while the values of coefficient of static friction were 0.30, 0.39 and 0.39, respectively for yarma grain and 0.38, 0.53 and 0.53, respectively for bulgur grain.

Key words: Yarma, bulgur, physical properties

INTRODUCTION

Bulgur is food product is usually processed from *Triticum durum* wheat using cooking, drying, peeling and grinding operations. It is widely popular in Turkey, as well as Arabic and Eastern European countries. In Turkey, bulgur production is 2.5 times greater than pasta production (macaroni). One million tones of bulgur per year is processed at 500 factories. Both the economic value and quality of bulgur exported are expected to increase in the future[1].

Triticum drum is the mostly preferred variety of wheat in bulgur production because of its colour, physical and chemical properties. Some hard variety of bakery wheat has been also used in bulgur production in Turkey, due to insufficient production and higher price of *Triticum drum*. There are two types of bulgur according to Turkish standard, one of them is for pilaff (3.55-1.66 mm), the another is for meatball (2.00-0.55 mm). In addition to, these two type, some other types of bulgur with different sizes and peculiarity are also consumed in high ratio in Turkey and Arabic countries[2].

Yarma is also one of the types of products of wheat. Its production includes peeling by using peel grinder. Physical properties of yarma and bulgur are to be known; for carrying out production of yarma, peeling, drying, calibrating, and production of bulgur, boiling, drying, peeling, crashing, calibration and packing in hygienic environment.

The objective of this study was to investigate some physical properties of the bulgur and yarma namely, linear dimensions, thousand grain mass, geometric mean diameter, sphericity, unit mass, bulk density, true density, repose angle and static and dynamic coefficient of friction against different materials.

MATERIALS AND METHODS

The yarma and bulgur used in the study were obtained from a local market in Tokat, Turkey. The bulgur samples used in the study were selected for pilaff according to TSI[3]. The samples were cleaned manually to remove all foreign matter, broken and immature grains. The moisture content of yarma and bulgur was determined by oven drying at 130°C for 3 h[3]. Each of the samples was replicated three times and the average initial moisture content of yarma and bulgur was 12.27 and 13.4% (d.b.), respectively.

Hundred grains were randomly selected and length, width and thickness were measured by a dial-micrometer to an accuracy of 0.01 mm. The geometric mean diameter (Dg) and spherity (⌀) of yarma was calculated by using the following formula[4]:

$$Dg = (LWT)^{0.333} \quad (1)$$

$$⌀ = (LWT)^{0.333}/L \quad (2)$$

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Where, L is the length, W the width and T is the thickness.

To obtain the 100-grain weight; 1000 grains were randomly selected from the bulk, divided in 10 groups and weighed by an electronic balance weighing to an accuracy of 0.001 g. The bulk density (ρ_b) was determined with a weight per hectoliter tester, which was calibrated in kg per hectoliter[5,6]. The true density (ρ_t) were determined using the liquid (toluene) displacement method. The volume of liquid displaced was found by immersing a weighed quantity of grains in the liquid[5,7-9].

The angle of repose is the angle with the horizontal at which the material will stand when piled. This was determined by using a topless and bottomless cylinder with 30 cm diameter and 50 cm height. The cylinder was placed at the center of a circular plate and was filled with yarma and bulgur. The cylinder was raised slowly until it formed a cone on a circular plate. The angle of repose was calculated from the measurement of the height of the cone and the diameter of the cone[10].

The coefficient of friction of yarma and bulgur were measured using a friction device. The device consist of metal box, friction surface and electronic unit, which covers mechanical force unit, electronic variator, load cell, electronic ADC card and PC. Load cell is connected to the metal box with iron bar. Top and bottom line open metal box is sized 30x30x30 cm^3. For the measuring of friction force, friction surface (galvanized steel, mild steel and plywood) is moved horizontally by the stationary velocity (0.02 m s^{-1}). Friction force values are measured by load cell, converted by ADC card and converted data is recorded in computer[11]. The maximum obtained value was used to calculate the static coefficient of friction and average value was used to calculate the dynamic coefficient of friction for each experiment.

RESULTS AND DISCUSSION

Results shows that the length of the yarma ranged from 5.22 to 7.49 mm, the width ranged from 2.41 to 4.00 mm while the thickness ranged from 2.06 to 3.54 mm (Table 1). The above parameters would be an important consideration in the development of sizing and grading machines and in their separation from undesirable materials. The geometric mean diameter and spherity value of yarma were found to range from 3.165 to 4.568 mm and 0.497 to 0.780, respectively. The weight of 100-grain of yarma and bulgur were found to be 4.36 and 1.02 g, respectively. The bulk density and true density of yarma and bulgur were between 690 to 720 kg m^{-3}; 1114.22 to 1392.11 kg m^{-3} and 760 to 770 kg m^{-3}; 1362.71 to 1486.09 kg m^{-3}, respectively. The angle of repose of yarma and bulgur were 14.4° and 16.2°, respectively (Table 1). The static and dynamic coefficient of friction for yarma and bulgur determined with respect to galvanized steel, mild steel and plywood surfaces. Both the static and dynamic coefficient of friction were the least for yarma and bulgur againts galvanized steel and the highest for plywood and mild steel. The values of coefficient of dynamic friction against galvanized steel, mild steel and plywood surfaces were 0.25, 031 and 0.34, respectively for yarma grain and 0.33, 0.39 and 0.45,

Table 1: Some engineering properties of yarma and bulgur at a moisture content of 12.27 and 13.4% (d.b.), respectively

	Values			
Particulars	Mean	Maximum	Minimum	SD
Yarma seed				
Length (mm)	6.350	7.490	5.220	0.52
Width (mm)	3.320	4.000	2.410	0.32
Thickness (mm)	2.940	3.540	2.060	0.32
Geometric Mean Diameter, Dg (mm)	3.947	4.568	3.165	0.31
Spherity (ø)	0.623	0.780	0.497	0.04
100 grain weight (g)	4.360	4.480	4.220	0.13
Bulk density ρ_b (kg m^{-3})	709.000	690.000	720.000	11.01
True density ρ_t (kg m^{-3})	1258.190	1392.110	1114.220	139.22
Angle of repose (°)	14.400	15.500	14.000	0.50
Coefficient of friction on				
Galvanised sheet	0.250	0.300	0.220	0.02
Mild steel	0.310	0.390	0.260	0.03
Plywood	0.340	0.390	0.220	0.03
Bulgur seed				
100 grain weight (g)	1.020	1.080	0.920	0.09
Bulk density ρ_b (kg m^{-3})	765.000	770.000	760.000	5.27
True density ρ_t (kg m^{-3})	1444.720	1486.090	1362.710	71.02
Angle of repose (°)	16.200	17.000	15.500	0.50
Coefficient of friction on				
Galvanised sheet	0.330	0.380	0.290	0.02
Mild steel	0.390	0.530	0.230	0.07
Plywood	0.450	0.530	0.390	0.03

respectively for bulgur grain; while the values of coefficient of static friction were 0.30, 0.39 and 0.39, respectively for yarma grain and 0.38, 0.53 and 0.53, respectively for bulgur grain.

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