J. Agr. Sci. Tech. (2012) Vol. 14: 65-76

Physical and Mechanical Properties of Alfalfa Grind as Affected by Particle Size and Moisture Content

Z. Ghorbani[1], A. Hemmat[1*], and A. A. Masoumi[1]

ABSTRACT

Physical and mechanical properties of alfalfa (*Medicago sativa, L.*) grind are required for optimum design of equipment used in transporting, processing and storage of the material. This study was conducted to determine the effect of particle size (2.38, 3.36 and 4.76 mm) and moisture content (8, 9.3 and 11% wb) on some physical and mechanical properties of alfalfa grind. These properties include: geometric mean diameter, bulk density, coefficient of static friction (on galvanized iron, Plexiglass, rubber and polished steel surfaces), filling angle of repose, coefficient of internal friction, cohesion, and adhesion to polished steel plate. The bulk density varied from 161.6 to 202.2 kg m^{-3}. The coefficient of static friction changed from 0.26 on polished steel plate to 0.87 on rubber surface. Larger particles with higher moisture content had the highest filling angle of repose (54.5°). The coefficient of internal friction varied from 0.64 to 0.88. The 2.38-mm alfalfa grind at moisture content of 11% (wb), and the 4.76-mm at moisture content of 8% (wb) had the highest and lowest cohesion (7.65 and 4.80 kPa), respectively. The adhesion on polished steel plate varied from 0.19 to 1.54 kPa.

Keywords: Alfalfa grind, Bulk density, Coefficient of static friction, Cohesion.

INTRODUCTION

Alfalfa (*Medicago sativa,* L.) often called "Queen of forages" is the most important forage crop species in the world. Good quality alfalfa hay contains digestible fibers and a range of useful minerals and vitamins. Since 1970, the processing of alfalfa to produce products such as pellets and cubes has been increasing due to ease of transportation and better digestion (Haiqing, 2004).

Physical and mechanical properties of alfalfa grind are required for optimum design of equipment being used in transporting, processing and storage of the material. Geometric mean diameter and particle size distribution of biomass grind are important factors affecting the binding characteristics for densification, and are also useful information in the design of pneumatic conveyors and cyclones (Mani *et al.*, 2004a).

Bulk density can be useful in sizing hoppers and storage facilities; it can affect the rate of heat and mass transfer of moisture during aeration and drying process. Moisture content, bulk density, true density and particle size and shape of biomass particles after grinding are important for downstream processing (Manlu *et al.*, 2003). Fathollahzadeh *et al.* (2008) reported that bulk density of barberry increased from 700.01 to 1,224.67 kg m^{-3} with increasing moisture content from 12.64 to 89.23% (wb).

The frictional behavior of biomass grind in all engineering applications is described by two independent parameters: the coefficient of internal friction and the coefficient of static friction. Coefficient of

[1] Department of Farm Machinery, College of Agriculture, Isfahan University of Technology, P. O. Box: 84156-83111, Isfahan, Islamic Republic of Iran.

[*] Corresponding author; e-mail: ahemmat@cc.iut.ac.ir