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Procedia Food Science 1 (2011) 557 – 562

Procedia Food Science

11th International Congress on Engineering and Food (ICEF11)

Effect of die material on engineering properties of dried pasta

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Abstract

Extruding wheat semolina dough through a Teflon die allows to process pasta with a smooth and even surface, whereas bronze die can be used to obtain a product with a rough texture. Little is known about the impact of the die material on pasta properties other than surface characteristics. Knowledge of pasta properties would be relevant to better understand pasta digestibility. The aim of this work was to analyse the impact of the die material on engineering properties of dried pasta. Pasta were processed with fine semolina using a pasta extruder equipped with a 2.5 mm Teflon or bronze die. They were dried inside an environmental chamber under a controlled atmosphere at 40°C or 80°C for 20 hours. Pasta shrinkage, porosity and effective moisture diffusivity were measured. Scanning electron microscopy (SEM) was performed to characterize the external structure of pasta. Results showed that extrusion with a bronze die induces the production of more porous and less dense pasta, but does not have an impact on pasta shrinkage and volumetric percentage of water lost replaced by air during drying. Effective moisture diffusivity coefficients were higher for pasta extruded with a bronze die compared to a Teflon die for both drying temperatures studied, which indicates that the use of a bronze die could induce a diminution of the drying time. SEM observations at 50X and 500X clearly showed that pasta microstructure was affected by processing conditions. These results highlight the importance of food processing and their impact on the microstructure and characteristics of food matrices. Since pasta can be regarded as a good matrix for the incorporation of bioactive compounds beneficial to health and well-being, further studies are needed to better understand how processing would affect pasta digestibility and the release of bioactive compounds in terms of bioaccessibility into the gastro-intestinal tract.

Selection and/or peer-review under responsibility of 11th International Congress on Engineering and Food (ICEF 11) Executive Committee.

Keywords: Pasta drying, porosity, shrinkage, effective moisture diffusivity, engineering properties, bronze die

1. Introduction

In order to produce cylindrically shaped pasta, dough is pressed through the die of an extruder to process it in the desired shape prior to the drying step. It is well known that the material of the die can

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Selection and/or peer-review under responsibility of 11th International Congress on Engineering and Food (ICEF 11) Executive Committee.
doi:10.1016/j.profoo.2011.09.084

deeply impact the surface properties of pasta. Teflon die leads to pasta with smooth and even surface with a bright-yellow appearance, whereas bronze die can be used to obtain pasta with a rough texture. The die material can also influence physical properties of pasta other than surface characteristics, bronze die leading to the production of more porous pasta with lower breaking strength [1]. While some studies have been performed to characterize structural properties [2-4] and drying kinetics [5-9] of pasta extruded with a Teflon die, little is known about the impact of other die materials on pasta properties other than surface characteristics. Knowledge of pasta properties would be relevant to better understand pasta digestibility. Therefore, the aim of this work was to analyse the impact of the die material on engineering properties of dried pasta.

2. Materials & Methods

2.1. Raw Materials

Roller-milled durum wheat semolina was purchased from Horizon Milling (Montreal, QC, Canada). Total protein content of semolina (N x 5.7) was determined using an FP-428 LECO apparatus (LECO corp., Saint Joseph, MI, USA). The instrument was calibrated with EDTA as nitrogen standard. Fineness of semolina was determined by sieving and expressed according to ANSI/ASAE method S319.4.

2.2. Pasta Processing

To process pasta, durum wheat semolina was hydrated to 49.3 g-water 100g-dry matter-1 in a stand mixer (Model Professional 600, Kitchenaid, St. Joseph, MI, USA) under constant agitation with a flat beater for 15 min. The mixture was transferred to a pasta extruder (Dymasters Pasta Dies & Extruder, Port Coquitlam, BC, Canada) equipped with a metallic pre-die (1.9 mm-sieve openings) and a Teflon or Bronze die (2.5 mm). During extrusion, vacuum pressure was applied (about 78 kPa) to prevent air bubble formation and temperature was controlled at 50°C with water circulating in a double-jacket chamber. Drying was performed in an environmental chamber (Model RTH-16P-2, Burnsco Technologies Inc., Kanata, ON, Canada) with fresh pasta deposited on metallic rods. Air velocity inside the chamber was between 1 and 2 m s-1. Two 20 hours drying profiles were used; one at constant low temperature (40°C) and one at constant high temperature (80°C). Relative humidity was kept at 65% for both drying profiles. Two batches of 1.5 kg of pasta were processed for each die material (Teflon and Bronze) and drying temperature.

2.3. Fresh and dried pasta properties measurements

Initial and final moisture contents of pasta were determined according to AOAC Method 925.09 by drying samples overnight in a vacuum oven at 92°C. During drying, pasta weight was measured online every minute with a 5-kg load cell (National Scale Technology, Huntville, AL, USA) connected to a data acquisition system (Model TI 500E, Transcell Technology, Buffalo Grove, IL, USA). Effective moisture diffusivity (D_{eff}) was determined with R considered as pasta initial radius according to a method previously developed [9]. Fresh and dried pasta dimensions (length and diameter) were measured using a digital caliper (Model 62379-531, Control Co. Friendswood, TX, USA). Measurements were conducted on 10 strands of pasta. Apparent density was calculated from the measured dimensions and the mass of pasta under the hypothesis of cylindrically shaped pasta. The volumetric shrinkage that occurred between the initial and final stage of pasta drying, the porosity and the fraction of water lost during drying replaced by air (η) were calculated according to a method previously developed [10].