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Usage of undersize bulgur flour in production of short-cut pasta-like couscous

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A B S T R A C T

Couscous is a traditional cereal product produced by rubbing durum semolina particles with water by hand, but can be produced by using pasta pressing technique. This study aimed to produce a short-cut pasta type couscous by substitution of semolina with undersize bulgur at 25, 50, 75 and 100%, by determining optimum parameters. Bulk density, cooking loss, volume and weight increases, protein and ash contents, color, sensory, texture and functional properties were determined. Couscous samples were prepared and dried using packed bed (60 and 80 °C) and microwave dryers (180 and 360 W) to determine optimum parameters. It was found that the quantity of bulgur flour was significantly ($p \leq 0.05$) effective on the sensory attributes, bulk density, cooking loss, volume and weight increases, protein and ash contents in contrast to functional properties. Weight and volume increase values decreased with increasing quantity of bulgur flour. Couscous samples containing bulgur flour have higher protein than the control due to higher protein content of bulgur. According to texture profile, hardness of couscous containing bulgur flour was lower than the semolina control for each drying technique. Results revealed the fact that the production of pasta type couscous is possible using totally undersize bulgur instead of semolina.

1. Introduction

Couscous, a world-wide known pasta-like traditional product, which is a staple food of North Africa (Aboubacar and Hamaker, 2000; Rahmani and Muller, 1996) and Middle East cuisines. It can be consumed as salad (tabulleh) and side dish with chicken and meat meals, as an alternative for pilaf. Depending on the formulation, processing technique and usage, there are three couscous types such as Turkish, Arabic/African and short-cut pasta-like. Turkish and Arabic/African type of couscous are produced traditionally by hand, which are different from pasta type. Pasta type couscous is generally produced mechanically by using extrusion technology (Celik et al., 2004). The basic industrial and traditional couscous processing steps are: a) mixing and agglomeration of *Triticum durum* semolina with water, b) steaming and c) drying (Aboubacar et al., 2006; Debbouz and Donnelly, 1996). Wheat flour, semolina, sorghum, millet, maize (Galiba et al., 1988) and barley (Kaup and Walker, 1986) can be used in the couscous production.

In Turkish type couscous, couscous is generally prepared by coating of bulgur granules with semolina, wheat flour and water or milk (Demir et al., 2010). Bulgur is a whole grain product, which is generally produced from *Triticum durum* wheat by cleaning, cooking, drying, tempering, peeling, milling, polishing and classification (Bayram and Öner, 2005, 2007; Hayta et al., 2003; Yıldırım et al., 2008a, b). Particle size of bulgur changes between 3.5 and 0.5 mm. After screening, bulgur is classified as coarse (>3.5 mm), pilaf (3.5–2.0 mm), medium (2.0–1.0 mm), fine (1.0–0.5) and undersize bulgur (<0.5 mm) (Yıldırım et al., 2008a, b). The amount of the by-product (undersize bulgur) is about 15% of total produced bulgur and this nutritionally valued products used as an animal feed.

In literature, traditional hand-made couscous production method is usually reported in researches as the addition of alternative grains such as sorghum in couscous formulations (Aboubacar and Hamaker, 2000; Aboubacar et al., 2006; Galiba et al., 1988). Debbouz and Donnelly (1996) compared home-made, commercial and extruded couscous samples according to their colors, water absorption indexes, degrees of starch gelatinization, cooking qualities and sensory attributes. They observed

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uniform size, intense yellow color and high degree of starch gelatinization for twin-screw-extruded couscous. In addition, cooking properties of chickpea flour used as a coating on couscous granules instead of wheat flour and then color values were measured and sensory evaluation was made (Demir et al., 2010). Moreover, gluten-free couscous is produced with rice, field bean proteaginous pea and chickpea flours (Benatallah et al., 2008).

The aims of this study are; to produce short-cut pasta type couscous by substitution of semolina with undersize bulgur (bulgur flour); to find optimum quantity of bulgur flour and drying conditions.

2. Materials and methods

2.1. Materials

Undersize bulgur (bulgur flour, <0.8 mm) produced from *Triticum durum* wheat was obtained from a local factory in Gaziantep, Turkey. Semolina produced from *Triticum durum* wheat (the particle size of between 0.5 and 1.00 mm) was obtained from local market. Distilled water was used in all experiments and formulations. All chemicals and standards used in proximate and phytochemical analysis were obtained from Sigma-Aldrich Chemie GmbH (Germany).

2.2. Couscous preparation

Experimental set-up is shown in Fig. 1. Short cut pasta type couscous was produced by using a small scale pasta machine (Dolly, La Monferrina, Italy) by substituting *Triticum durum* semolina with undersize bulgur at different quantities (25, 50, 75 and 100%). The quantities were given in total flour weight (w/w). The quantity of water to prepare dough was obtained by trial and error based on suitable dough stickiness and consistency. The control couscous sample was produced using the quantity of 100% durum semolina and 0% of bulgur flour. The quantity of water was calculated according to total flour weight. Yields (%) were calculated by weighing total mix and produced uncooked couscous.

2.3. Drying

Couscous was dried to 12% (w.b.) of moisture content by packed bed dryer (MR II, Sherwood Scientific, Cambridge, England) and microwave (HMT84G421, Bosch, Germany). Drying was made at two different temperatures such as 60 and 80 °C for packed bed dryer (air velocity: 0.35 m/s, volumetric flow rate: $6.19*10^{-3}$ m^3/s) and at two different power intensities such as 180 and 360 W for microwave dryer. Six hundred grams of sample was placed into the dryers. Weight of sample was recorded at the beginning of the drying operation. Weighing was made until the sample reaches to 12% of moisture content within 4 min intervals.

2.4. Determination of optimum processing parameters and recipes

The couscous samples were produced with 0, 25, 50, 75 and 100% as compositions by using packed bed (60 and 80 °C) and microwave (180 and 360 W) dryers. In order to determine the optimum processing parameters and recipes, sensory attributes and color values (L*, a*, b*, YI and sensory color results) were used and the recipes were used for further analysis (protein, ash, volume and weight increase, cooking loss, bulk density, texture properties and sensory analysis).

2.5. Moisture content measurement

Association of Official Analytical Chemists (AOAC) methods was used for the determination of moisture content before drying using 3–4 g of sample in an oven (JS Research Inc., Korea) at 130 °C until constant weight reached (AOAC, 1990).

2.6. Ash content measurement

AOAC (1990) method was used to measure ash content of couscous (%, d.b.).

2.7. Protein content measurement

AOAC (1990) Kjeldahl method was used to measure protein content of couscous (%,d.b.).

2.8. Color measurements

Color of the dry samples before the cooking operation was determined by measuring the CIE L^* (100 = white; 0 = black), a^* (+, red; -, green) and b^* (+, yellow; -, blue) and *YI* (Yellowness Index) values using QUEST II Minolta CR-400 (Minolta Camera, Co., Ltd, Osaka, Japan) with illuminate D65/10 as reference. The presented color results were the average of four measurements.

2.9. Analysis of percent changes in cooking loss (% CL), volume (% VI) and weight (% WI)

Percent changes in cooking loss (% CL), volume increase (% VI) and weight increase (% WI) were determined by modification of the method presented by Demir et al. (2010) for short cut pasta type couscous samples. In this method, 10 g of couscous were cooked in 100 ml distilled water for 5 min. After cooking, the samples were washed by using distilled water, and then drained during 2 min. The drained cooking water was dried in an oven (JS Research Inc., Korea) until reaching constant weight. Then, % CL was calculated by using Eq. (1).

$$CL\ (\%) = 100x\ (\text{weight of residue in cooking water})/(\text{weight of dry sample}) \quad (1)$$

WI was determined by differences between dry (uncooked, before cooking) and cooked (after draining) couscous weights (Eq. (2)).

$$WI\ (\%) = 100\times\ (\text{weight of cooked sample-weight of dry sample})/\text{weight of dry sample} \quad (2)$$

% VI's of dry (uncooked) and cooked couscous samples were determined, individually. In order to determine % VI, 10 g of sample poured in a 250 ml graduated cylinder, then 50 mL of distilled water was added to measure water level increase. % VI was calculated by using Eq. (3).

$$VI\ (\%) = 100\times\ (\text{volume of cooked sample - volume of dry sample})/\text{volume of dry sample} \quad (3)$$

2.10. Bulk density analysis

For bulk density measurement, 10 g of couscous was poured into 50 mL graduated cylinder and the volume of couscous was recorded. Bulk density was determined by the ratio of weight of couscous to volume of couscous as kg/m^3.