PE4.27 Olive dietary fibers as restricting factor of oil uptake in meatballs during deep fat frying 100.00

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Abstract— A water soluble dietary fiber containing material was recovered from the olive mill wastewater and characterized with regard to fiber and ion content. Thereafter, it was utilized as fat replacement in meatballs together or separately with other additives like carrot and compared with regard to the total, water and fat loss or oil uptake during deep fat frying of the meatballs. Results indicated that this material is able to restrict the oil uptake of the meatballs during frying, but it was not able to reduce their water losses. On the other hand, meatballs prepared with this material and additional carrot insoluble fibers possessed both advantages (water holding ability and reduced oil uptake) and thereby they sustained reduced fat content.

I. INTRODUCTION

The growing demand by consumers for healthier products is stimulating the development of meat products with reduced fat contents and altered fatty acid profiles. Thus, there is an expanding new category of products that acquire added nutritional value as a result of a significant reduction in their fat and calorie contents, and in their saturated fat and cholesterol levels [1].

Dietary fiber (DF) is defined as the remnants of the edible plant cells, constituting of polysaccharides, lignin and associated substances resistant to digestion by human alimentary enzymes [2]. According to well-documented studies, it is now accepted that DF plays a significant role in many physiological processes and in the prevention of several diseases, and that diets with a high content of fiber have a positive effect on health, since its consumption has been related to a decreased incidence of several type of cancer [3]. The importance of fibers has led to the development of a large and potential market for fiber-enriched food products, as well as ingredients and gelling agents. For example, fibers from several vegetables (cauliflower, tomato, carrot, Swedish turnip, cabbage etc) have been used as a fat replacement in meat products [4]. Fruit fibers (orange, apple and peach) have been utilized in the preparation of reduced fat sausages with an acceptable sensory profile [2, 5]. Nowadays, there is a trend to find new sources of DF and the possibility of using undervalued agro-industrial wastes as raw materials is also an important economical aspect of the overall process. Manufacture of several fruits and vegetables (i.e. orange, apple, peach, olive, pepper, artichoke, onion and asparagus) produces a by-product from which can be recovered fiber fractions with a great potential in the preparation of functional foods [3]. Olive fruit contains an appreciable amount of fiber with promising functional properties like water holding and cation exchange capacity [6].

The production process of olive oil generates a by-product in different forms and compositions, which is known as olive mill wastewater (OMW). It is a mixture comprised of 83–94% w/w water, 4–16% organics (sugars, nitrogenous compounds, volatile acids, fats, polyphenols and fibers) and 0.4–2.5% inorganic compounds (mainly potassium salts and phosphates) [7].

The objective of this study is the utilization of fibers recovered from OMW as a fat replacement in meat products. A water soluble fiber containing material was recovered from OMW and characterized with regard to fiber and ion content. The recovered material was utilized as a fat replacement in meatballs together or separately with other additives like carrot and compared with regard to the cooking properties (water, fat and total losses).

II. MATERIALS AND METHODS

A. Recovery and characterization of the fiber containing material from OMW

OMW samples were collected from a local three phase olive mill production unit (Chania, Greece). Fresh sample (30 oC) was collected from the output of the decanter and kept in plastic containers in the freezer (-20 oC) until usage. The fiber containing material (alcohol insoluble residue - AIR) was recovered from OMW according to the patent WO/2008/082343 [8].

Thereafter, AIR samples (200 g dry matter) were dispersed in 10 Kg distilled water with a magnetic stirrer overnight at 10 oC and resulted mixtures were centrifuged with 3000 g at 20oC for 20 min in order to separate the fiber into its soluble/insoluble part. Three layers were produced: the pellet, supernatant fats and an aquatic liquid between the pellet and the fats. The supernatant fats were removed with a spoon and then the pellet was separated from the aquatic liquid. The amount of this soluble fraction was determined by weighing the liquid and further freeze-dried to remove the water and ground. This powdered residue was named Water Soluble Alcohol Insoluble Residue (WSAIR).

Ash content of the WSAIR was determined by drying in a 70 oC vacuum oven overnight and at 550 oC for 4 h in a furnace. Potassium and sodium content was determined using the AOAC Flame Photometric Method 956.01 [9], whereas calcium content was measured, using the AOAC AAS Method 975.03 [10]. Chlorine concentration of the AIR fractions was determined by titration with a standard silver nitrate solution in the presence of chromic ions as an indicator (Mohr titration method). The galacturonic acid (GalA) and the DF content of the samples were determined using the AOAC Uppsala Gas Chromatography-Colorimetric-Gravimetric Method 994.13 [11]. All measurements were performed in triplicate.

B. Preparation, frying and cooking losses of the meatballs

Potato flour was obtained from Lyckeby Stärkelsen Food & Fibre AB (Sweden). The meat raw material (fat and lean brisket beef) was achieved from a slaughterhouse (Ugglarps AB, Sweden). Frozen carrot cubes as well as potato and onion peels were supplied from Magnihill AB (Sweden). All these raw materials were separately ground with a meat mincer through a 3-mm grinder plate (AB Schauber & CO, Sweden). The minced quantities of each ingredient were then well mixed. Thereafter, the mix was immediately placed in plastic vessels and stored in the freezer (-20 °C) until used. Different meatballs were prepared with several combinations of meat (lean or fat) with or without starch and fibers from either OMW or carrots. The ingredients of the meatballs were mixed in different proportions inside a blender for 5 min. WSAIR samples were dispersed in the added water, prior to mixing in the blender. The total batch mass ranged between 500 and 600 g for all the tested samples. After the preparation of the batch, 30 meatballs of approximately 15 g and 3 cm diameter were prepared and allowed to stand in the fridge (5 oC) for 30 min.

A sunflower oil bath (160 oC) was used for deep fat frying. Fifteen meatballs in duplicates were weighed and placed on oil paper into a metallic orthogonal cage (20×12×5 cm). Thereafter the cage was placed inside the oil bath and the meatballs were cooked for 3 min, reaching an inner mid temperature of about 75 oC. The cooked meatballs were placed on paper for at least 1 h in order to remove the external oil and to lower the temperature of the meat balls to room temperature before weighing. The water and fat contents of the raw and the fried meatballs were measured according to the method described by Oroszvári, Bayod, Sjöholm & Tornberg [12]. The calculation of the water, fat and total losses during cooking was obtained according to the same reference.

III. RESULTS AND DISCUSSION

A. Characterization of the recovered fiber containing material

WSAIR material contained very high amounts of inorganic compounds (46.2% w/w ash content) and basically potassium (10.4%). Other ions like sodium, calcium and chlorine existed in lower amounts (1.3, 0.6 and 2.6%, respectively). Moreover, WSAIR contained polysaccharides mainly composed of pectin material (5.6% total fibers and 5.3% pectin).

B. Meatball preparation Two tested meatballs samples were prepared with the addition of fiber material (WSAIR prepared with or without carrot fibers) and compared against four control samples (prepared with or without potato flour). Starch is generally used in meat formulations as a texturising component [13] and herein it is utilized in the form of potato starch as the standard water holding agent.

Table 1 shows the proximate composition of the assayed meatballs recipes as calculated from the content of the raw materials. The W/P ratio was kept constant (8.24-8.27) for all the samples (recipes 1-6) in order to avoid interferences in the water holding ability from meat proteins. The first control sample possessed high fat and starch content (14.0 and 8.5%, respectively). All the other control and tested meatballs (recipes 2-6) were prepared with lean brisket beef and characterized by low fat (1.2-1.4%) and rather constant protein content (9.5-10.2%). The second and third control samples with low fat content possessed high (7.8%) and low (1.1%) starch content, respectively. The first three control samples (recipes 1-3) contained fibers in the low concentration range (0.3-0.4%), while the fourth control sample possessed a bit higher fiber content (0.5%) due to the additional carrot. All the tested samples (recipes 5-6) possessed low starch content (1.0-1.1%) as well as higher fiber content (0.6%).

C. Cooking losses during frying Table 2 shows the cooking losses (water, fat and total) of the meatballs samples during deep fat frying. The samples with additional starch (recipes 1 and 2) show the lowest values (23.4 and 28.5%, respectively), whereas the highest water loss (48.1%) was observed for the sample prepared without any additive (recipe 3). Significant lower water loss (43.6%) was observed for the carrot containing sample (recipe 4). The WSAIR containing samples (recipes 5 and 6) possessed even lower water losses (41.6 and 41.9%, respectively), but the values were not significantly different from those observed for the carrot containing samples.

With regard to the fat losses, the only sample prepared with high fat content show losses of 4.1%. All the assayed meatballs prepared with lean beef show negative fat losses indicating oil uptake. The control sample with additional starch (recipe 2) shows an oil uptake of 1.3% w/w, whereas the control sample prepared without any additive (recipe 3) shows more than twofold higher in oil uptake (3.2%). The sample prepared with the addition of carrot (recipe 4) give rise to similar values (3.1%). On the other hand, the sample prepared with a combination of carrot and WSAIR (recipe 6) shows a significantly lower value of 2.2%, while the sample prepared with only WSAIR (recipe 5) possesses the lowest oil uptake (0.5%). Finally, the corresponding total losses of all the assayed samples followed more or less the order and the magnitude of the water losses, despite the observed variation in the oil uptake.

However, the percentage of the oil uptake with regard to the properties of the fiber additives is important to state. The two samples (recipes 5-6) possess the same fiber content (0.6%), but different percentages of oil uptake. For example, the lowest value of oil uptake was observed for the sample that contains most water soluble fibers (recipe 5), while higher value was obtained for the sample that contain insoluble fiber material from carrot (recipes 4 and 6). This indicates that soluble fibers can reduce the oil uptake of the product. A possible explanation could be that soluble fibers are able to form a gel network that increases the viscosity of the water phase of the meat balls, which probably would restrict the oil penetration into the core of the meatball.

It is important to further underline the observations made in this investigation, that oil absorption easily occurs during deep fat frying and it is therefore difficult to achieve low fat meat balls by frying if not using something able to restrict the oil uptake. We have therefore in Table 3 given the water and fat content of the meatballs, prior and after frying. All the assayed meatballs prepared with lean beef show much higher (two to five fold) fat content after frying. Moreover, the cooked meatballs prepared with lean beef but without any additive (recipe 3), show a fat content which is comparable to that one obtained for the sample prepared with fat beef and starch (recipe 1): 9.4 and 11.2%, respectively. The lowest fat content (3.4%) is observed for the sample prepared with lean beef and additional starch (recipe 2). The sample prepared with additional WSAIR (recipe 5) posses the second lowest fat content (4.4%), due to the fore-mentioned low oil uptake (0.5%). Due to the higher oil uptake during frying the water content of the meatballs are reduced: 65-82% and 58-65% prior and after frying, respectively.

On the other hand, the meatballs prepared with lean beef and starch or carrot (recipes 2 and 4) possesses the higher water contents (65.1 and 64.7%, respectively). Although the percentage of oil uptake (0.5-3.6%) during frying was relatively low the resulting fat content of the cooked meatballs is high (3.4-9.5%), because we have an additive effect of the higher water losses compared to fat losses during frying. Potato starch is proven to be a very good meatball additive in comparison with the other assayed samples, as it provides a product with higher water and lower fat content. With regard to the fiber additives, carrot showed the best water holding capacity, while WSAIR possessed the lowest oil absorption ability during frying.

IV.-CONCLUSION

A fiber containing material (WSAIR) was recovered from OMW and utilized alone or in combination with carrot as fat replacement in meatballs. This material contains exclusively water soluble fibers, which were able to reduce water losses as well as oil uptake in low fat meatballs (recipe 5). However, these meatballs possessed "metallic" taste due to the high contents of potassium (all the assayed meatballs were simply tasted without a regular panel test). On the other hand, the meatballs prepared with both the WSAIR and the insoluble fibers from carrot (recipe 6), combined advantages like water holding ability, reduced oil uptake and improved taste. Conclusively, WSAIR material could be utilized as meatball additive in order to reduce undesirable oil uptake for meatballs with reduced fat content. Further investigations are needed in order to purify WSAIR material from ions with a final purpose of improving its taste and water-holding properties.

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