Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

Arch Lebensmittelhyg 68,
133–139 (2017)
DOI 10.2376/0003-925X-68-133

© M. & H. Schaper GmbH & Co.
ISSN 0003-925X

Korrespondenzadresse:
okilincceker@adiyaman.edu.tr

Department of Food Processing, Technical Sciences Vocational School, University of Adıyaman, TR-02040, Adıyaman, Turkey

Some quality characteristics of chicken meatballs formulated with different dietary fibers

Qualitätsmerkmale von Hühnerfleischbällchen hergestellt mit verschiedenen Ballaststofffasern

Osman Kilincceker

Summary

Wheat, cellulose and oat fibers were investigated in the production of chicken meatballs. pH, TBA, and color values were determined for raw samples at cold storage for the 1st, 5th, and 10th days. Effects of fibers and its levels on the some technological and sensory properties of fried meatballs were determined. Cellulose fiber and oat fiber more improved the storage stability of raw samples than wheat fiber. Storage increased the pH and TBA means whereas decreased *L, a* and *b* values, generally. Cellulose fiber had better effect on color and technological properties of fried meatballs. Addition of wheat fiber and cellulose fiber decreased the frying yields. However, fiber addition decreased the diameter reductions, penetrometer values, and some sensory properties of samples. Consequently, it can be said that the use of cellulose fiber at 8 and 12 % levels is more advantageous than other samples.

Keywords: chicken meatball, wheat fiber, cellulose fiber, oat fiber, quality

Zusammenfassung

Es wurden Hühnerfleischbällchen mit Weizen-, Zellulose- und Haferfasern hergestellt und untersucht. Bestimmt wurden die pH-, TBA- und Farbwerte der rohen Proben während einer Kühllagerung am 1., 5. und 10. Tag. Des Weiteren wurden die Auswirkungen auf die technologischen und sensorischen Eigenschaften der gebratenen Fleischbällchen bestimmt. Zellulosefasern und Haferfasern verbesserten die Lagerstabilität der rohen Proben stärker als Weizenfasern. Im Allgemeinen erhöhte die Lagerung den pH-Wert und die Thiobarbitursäure-Werte (TBA) deutlich und die Farbwerte (L-, a- und b-Werte) erniedrigten sich. Zellulosefasern hatten eine bessere Wirkung auf die Farbe und die technologischen Eigenschaften von gebratenen Fleischbällchen. Die Zugabe von Weizenfasern und Zellulosefasern verringerte die Frittierausbeute. Die Zugabe der Fasern verringerte jedoch die Durchmesserabnahme, die Penetrometerwerte und einige sensorische Eigenschaften der Proben. Es kann festgehalten werden, dass die Verwendung von Zellulosefasern bei 8 % und 12 % vorteilhafter ist, als bei anderen Proben.

Schlüsselwörter: Hühnerfleischbällchen, Weizenfaser, Zellulosefaser, Haferfaser, Qualität

Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

Ausgabe für imr:livelyzachary
Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.
Journal of Food Safety and Food Quality 68, Heft 6 (2017), Seiten 125–146

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

Introduction

The demand for low-calorie chicken meat products has much increased in recent years due to consumer's interest about diet foods. High fat content in these products may cause obesity, high cholesterol, coronary heart disease and some types of cancer (Khalil 2000; Kilincceker 2017).

Thus, manufacturers and scientists are trying to solve these problems by reducing the fat levels in foods. They want to improve some physical, chemical and sensory characteristics by using some ingredients that are plant based. Some proteins, gums, plant extracts and fibers are examples of these ingredients. Functional properties of these materials affect food production applications and these properties depend on their sources (Sanchez-Zapata et al. 2010; Petracci et al. 2013).

Especially, many researchers reported that the use of different fibers improved quality properties of meat and chicken meat products. These results are interpreted as a result of water and fat binding properties of these fibers. Additionally, they reported that antimicrobial and antioxidant features of fibers also contribute easily to the degradable food (Talukder and Sharma 2010; Cava et al. 2012; Gadekar et al. 2016)

During the manufacture of these products, fat can be replaced by water and dietary fiber which increase chemical and textural properties and stability of storage (Cava et al. 2012; Kilincceker and Yilmaz 2016).

After frying, cooking yield, diameter reduction and color can be improved and moisture loss and fat level can be decreased. In this way, the attraction of the product to consumer are increased whereas economic losses can be reduced (Talukder and Sharma 2010; Cava et al. 2012).

However, studies on chicken meat and dietary fibers are thought to be inadequate. Thus, in this study, usage possibilities of wheat fiber, cellulose fiber and oat fiber in chicken meatballs were investigated. Also, various alternatives were offered to consumer with different fiber levels.

Materials and Methods

Materials

Wheat fiber, cellulose fiber, and oat fiber purchased from Kimbiotek Co. (Istanbul). Some properties of fibers are summarized in table 1. Chicken breast fillets and other materials were obtained from a local market and stored under 4 °C until the experimental procedures. Fillets were produced in an integrated slaughterhouse and air chilled before packaging. All fillets were chopped to smaller proportions and were minced using no:3 coded plate attached meat grinder (Tefal, Le Hachoir 1500, France). Ingredients and formulation for meatball designed to include: 9500 g minced meat, 150 g salt (NaCl), 100 g black pepper (Irradiated), 50 g curry and 200 g sunflower oil (Yudum, Turkey). The mixture was kneaded for homogenization and set for 30 min under 4 °C. The mixture was separated into ten groups. Groups were designed as supplement with 4, 8, 12 % of wheat fiber, cellulose fiber and oat fiber and no treatment control group. Each group was divided into equally two parts and meatballs (approx. 20 g weight and 30 mm diameter for each sample) were made from each group. First group of meatballs was placed on plastic plates and covered with stretch film, stored at 4 °C. pH, TBA and color values of these samples were determined during storage. Second group was used to determine some technological and sensorial properties of fried meatballs at 175 °C for 5 min.

Methods

Determination of pH, TBA (thiobarbutiric acid) Values and Color Measurement

pH values, thiobarbutiric acid (TBA) and, color analyzes were performed on the 1st, 5th and 10th days of post-production. pH values were measured with a pH meter (Orion 3-Star, Thermo fisher Scientific, Waltham, MA) after homogenization ten grams of sample with 100 ml deionized water for 1 min following the instructions outlined by Ockerman (1985). Determination of the extent of oxidative rancidity of the samples on the 1st, 5th, and 10th days of storage which was described by Tarladgis et al. (1960) was used. For this purpose, the samples were blended in a commercial blender. Then, ten grams of the blended samples was mixed with 50 mL distilled water at 50 ºC. The homogenate was transferred to an 800-mL Kjeldahl flask. It was added 48 mL of distilled water (50 °C) and 2 mL of 18 % HCl. The resulted mixture was heated, and the first 50 mL of distillate was collected. Five milliliters of the distillate was added to 5 mL on TBA reagent, and was heated in a boiling water bath for 35 min. The absorbance was read at 538 nm (UV-160 A, UV-Visible Recording Spectrophotometer, Shimadzu, Tokyo, Japan) against a reagent blank. TBA results were expressed as mg of malonaldehyde/kg samples. Color was measured by using a portable colorimeter using Minolta Chroma Meter CR-400 (Konica Minolta, Inc., Japan) with illuminant D 65, 2° observer, Diffuse/O mode, 8 mm aperture of the instrument for illumination and 8 mm for measurement. The instrument was calibrated with a white reference tile (L=97.10, a= –4.88 and b=7.04) before the measurements. Color was described according to CIELAB system as L (lightness), a (redness), and b (yellowness) values (Dogan 2006).

Technological Properties and Sensory Evaluation

Chicken meatballs were evaluated for technological properties and sensory characteristics. For this purpose, meatballs were measured for weight, diameter, moisture and fat values before and after frying in mini fryer (Tefal, Moulinex Minuto AF100316). Additionally, penetrometer, color and sensory evaluation were made after frying. Determination of cooking yield parameters.

Weights and diameters of meatballs before and after frying were used to calculate frying yield and diameter reduction parameters according to the equations 1 and 2 (Kilincceker 2017):

$$\text{Frying yield (\%)} = \frac{\text{cooked meatball weight}}{\text{raw meatball weight}} \times 100 \quad (1)$$

$$\text{Diameter reduction (\%)} = \frac{\text{raw meatball diameter} - \text{cooked meatball diameter}}{\text{raw meatball diameter}} \times 100 \quad (2)$$

Moisture contents of raw and fried samples were determined by oven air method at 105±2 °C whereas fat contents were evaluated by using soxhlet extraction method with n-hexane (AOAC 2002). Moisture retention and fat absorption parameters were calculated according to the equations 3 and 4 (Soltanizadeh and Ghiasi-Esfahani 2015).

$$\text{Moisture retention} = \frac{\text{moisture in cooked meatball (\%)}}{\text{moisture in raw meatball (\%)}} \times \text{frying yield} \quad (3)$$

Ausgabe für imr:livelyzachary
Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

Fat absorbtion = fat in cooked meatball (%) – fat in raw meatball (%) (4)

Determination of Instrumental Hardness Values

Hardness is among the most important indicators in determining the meat tenderness quality. In measuring meat hardness, the penetrometer test is widely used. For this purpose, a penetrometer (Yüksel Kaya Mechanics, Turkey) equipped with a total of 56.2 g-load was used to measure the hardness values according to ASTM D 1321 standard method. In order to measure the hardness of the cooked meatballs at the end of 5 min after frying, a needle was left to vertically free fall from the same distance for each sample. The penetration depth was read as the mm after 3 s of penetration.

Sensory Evaluation

Chicken meatballs were served warm (35 ºC) in random order to ten trained panelists (graduate students of Adiyaman University, Department of Food Processing) 2 min after frying. In preliminary sessions, trainings were made for evaluation of the meatball treatments to the panelists. Panelists assessed the sensory properties by using a hedonic scale in terms of appearance, color, odor, flavor, and texture. Values in the scale indicate the following ratings: 1: extreme dislike, 2: very much dislike, 3: moderate dislike, 4: slight dislike, 5: neutral, 6: like slightly, 7: like moderately, 8: like very much, 9: like extremely (Gokalp et al. 1999).

Statistical Analysis

The experimental procedure was designed in two replications and three parallels. As a factorial design, three different levels (4, 8, and 12 %) of three different factors (wheat, cellulose and oat fibers) were studied. The results were evaluated by using variance analyzes and importance was re-evaluated by using Duncan Test ($p<0.05$). It is summarized in Fig. 1.

Results and Discussion

The quality of chicken meat and its products are affected by protolithic and oxidative deterioration that occurs during storage. Ammonia increases pH value whereas oxidation of fatty acids cause increasing of TBA value. They cause bad smell and taste. Therefore pH and TBA levels can be used as indicators of meat quality. Also, the color can be affected by these values and it affects consumer's choices. In addition, color can be changed by additives and storage. Thus, it is suggested to determine these properties periodically (Gokalp et al. 1999).

pH and TBA values of raw samples in different storage times are shown in table 2. According to results, fiber type, fiber concentrations and storage generally affected pH values of raw meatballs. Cellulose fiber and oat fiber decreased pH values compared to wheat fiber. Addition of wheat fiber increased pH values at 1st and 5th days and addition of cellulose fiber decreased it at 10th day. Storage also increased pH values of raw meatballs. At the end of the 10th day, lowest pH values were in samples with 8 % and 12 % oat fiber as 6.20 and 6.18 (table 2).

Wheat fiber had more advantageous than other fibers on TBA. Especially, addition of cellulose fiber decreased TBA values at the end of the 5th storage day whereas samples with cellulose and oat fibers had higher values than control. However, TBA values increased during cold storage. Lowest TBA results at the end of the 10th day were determined in samples with 4 %, 8 % and 12 % wheat fiber (in range of 0.12–0.14 mg malonaldehyde/kg samples, table 2). In our results, oat fiber might decrease pH values of the chicken meatballs because of its acidic character.

As the same, Kilincceker (2017) reported that storage has a parallel connection with increasing of pH in raw poultry products. Sanchez-Zapata (2010) found that various concentrations of nut fiber in pork burger had not effect on pH and they determined that pH values of

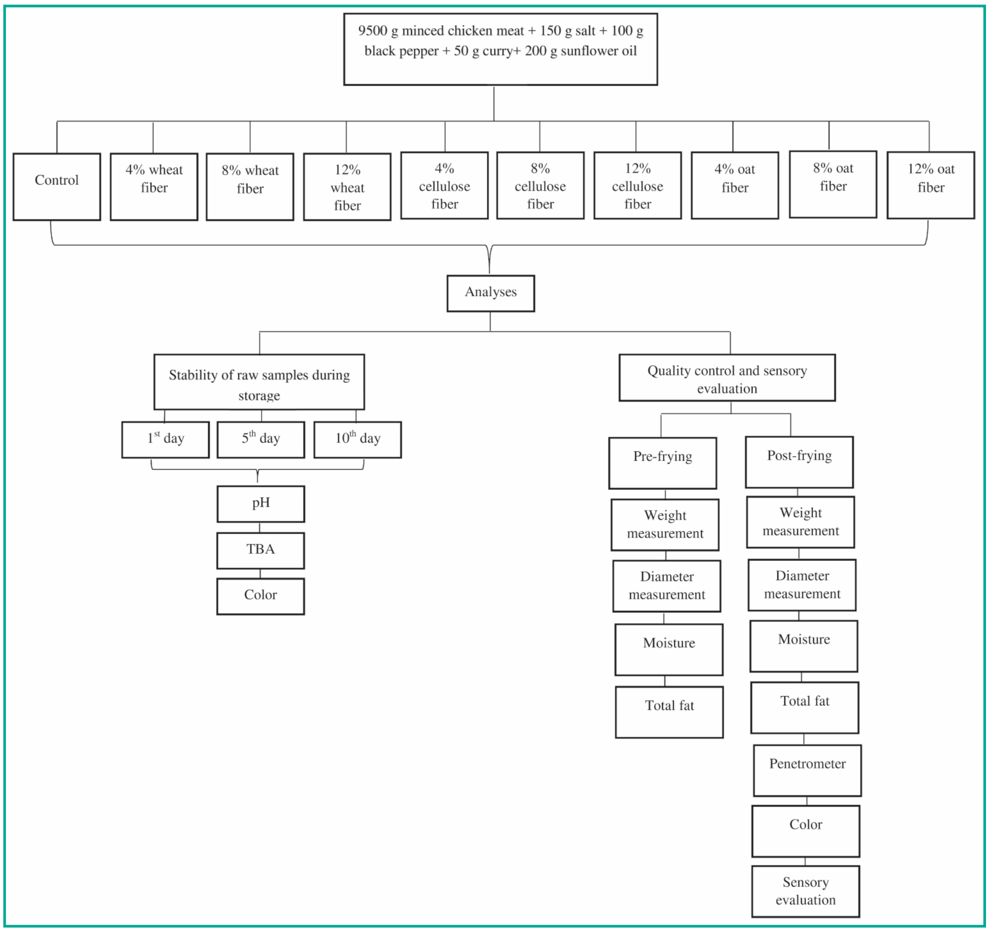

FIGURE 1: *Flow chart of chicken meatball formulations and analyses.*

TABLE 1: *Some properties of the fibers.*

Fiber type	Moisture (%)	Particle size (µm)	TFC (%)
Wheat	7	< 250	93
Cellulose	7	< 250	95
Oat	7	< 250	93

TFC: Total fiber content

Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

Ausgabe für imr:livelyzachary
Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

TABLE 2: *Effect of fiber type and concentration on pH, TBA and color values of raw meatballs at different storage periods.*

		1st day Fiber concentration				5th day Fiber concentration				10th Fiber concentration			
	Fiber type	Control (0 %)	4 %	8 %	12 %	Control (0 %)	4 %	8 %	12 %	Control (0 %)	4 %	8 %	12 %
pH	Wheat	6.05^{aDY}	6.12^{aCY}	6.18^{aBY}	6.23^{aAY}	6.10^{aBY}	6.18^{aBY}	6.23^{aAXY}	6.25^{aAXY}	6.24^{aAX}	6.25^{bAX}	6.25^{aAX}	6.28^{aAX}
	Cellulose	6.05^{aAY}	6.06^{bAY}	6.07^{bAY}	6.07^{bAY}	6.10^{aAX}	6.10^{aAY}	6.11^{bAY}	6.11^{bAY}	6.24^{aBX}	6.37^{aAX}	6.24^{aBX}	6.22^{abBX}
	Oat	6.05^{aAY}	6.05^{bAY}	6.03^{bAY}	6.01^{cAY}	6.10^{aAY}	6.08^{aAXY}	6.16^{abAX}	6.06^{bAY}	6.24^{aAX}	6.24^{bAX}	6.20^{aAX}	6.18^{bAX}
TBA mg/kg	Wheat	0.075^{aAY}	0.06^{bAY}	0.07^{aAY}	0.08^{aAX}	0.12^{aAX}	0.10^{aAX}	0.12^{aAX}	0.12^{aAX}	0.12^{aAX}	0.12^{bAX}	0.14^{bAX}	0.14^{aAX}
	Cellulose	0.075^{aAY}	0.09^{aAY}	0.08^{aAY}	0.08^{aAY}	0.12^{aABX}	0.14^{aAY}	0.13^{aABX}	0.09^{bBY}	0.12^{aBX}	0.27^{aAX}	0.19^{aABX}	0.21^{aAX}
	Oat	0.075^{aAY}	0.085^{abAY}	0.10^{aAY}	0.09^{aAZ}	0.12^{aAX}	0.08^{aAY}	0.09^{aAY}	0.12^{aAY}	0.12^{aBX}	0.23^{aAX}	0.23^{aAX}	0.23^{aAX}
L	Wheat	38.40^{aBX}	44.92^{aAX}	46.45^{aAX}	47.24^{bAX}	38.92^{aCX}	43.54^{abBX}	44.90^{bABXY}	46.03^{bAX}	39.22^{aBX}	40.26^{bBY}	43.83^{bAY}	44.78^{bAX}
	Cellulose	38.40^{aCX}	45.64^{aBX}	50.21^{aAX}	53.04^{aAX}	38.92^{aDX}	45.02^{aCX}	49.40^{aBX}	52.23^{aAX}	39.22^{aCX}	44.51^{aBX}	48.02^{aAX}	50.19^{aAY}
	Oat	38.40^{aBX}	44.15^{aAX}	45.83^{aAX}	47.47^{bAX}	38.92^{aCX}	42.43^{bBX}	45.09^{bAX}	45.70^{bAXY}	39.22^{aBX}	41.47^{abABX}	43.45^{bAX}	43.82^{bAY}
a	Wheat	1.95^{aAX}	1.78^{aAX}	1.68^{aAX}	0.94^{aBX}	1.33^{aAXY}	1.31^{aABY}	1.18^{aBY}	0.60^{bCXY}	1.09^{aAY}	0.89^{aAZ}	0.45^{aABZ}	0.11^{aBY}
	Cellulose	1.95^{aAX}	1.52^{bABX}	1.17^{aABX}	0.77^{aBX}	1.33^{aAXY}	1.35^{aAX}	0.75^{bBX}	0.36^{bBX}	1.09^{aAY}	0.74^{aAX}	0.48^{aAX}	0.04^{aAX}
	Oat	1.95^{aAX}	1.66^{bABX}	1.44^{aBX}	1.34^{aBX}	1.33^{aAXY}	1.19^{aAXY}	1.18^{aAXY}	1.13^{aAX}	1.09^{aAY}	0.59^{aAY}	0.52^{aAY}	0.14^{aAY}
b	Wheat	13.39^{aCX}	17.89^{bBX}	19.62^{bAX}	20.27^{bAX}	13.41^{aDX}	17.71^{aCX}	19.27^{bBX}	20.28^{bAX}	15.13^{aCX}	16.49^{bBCY}	18.69^{bABX}	19.69^{bAX}
	Cellulose	13.39^{aDX}	19.18^{aCX}	21.81^{aBX}	23.45^{aAX}	13.41^{aDX}	18.99^{aCX}	22.15^{aBX}	23.96^{aAX}	15.13^{aCX}	19.07^{aBX}	22.04^{aAX}	23.16^{aAX}
	Oat	13.39^{aCX}	18.00^{abBX}	19.45^{bAX}	20.95^{bAX}	13.41^{aDX}	17.42^{aCX}	19.41^{bBX}	20.58^{bAXY}	15.13^{aBX}	17.22^{abABX}	18.85^{bAX}	19.19^{bAY}

$^{a–c}$: Within each column, different superscript lowercase letters show differences between the fiber types within each concentration ($p < 0.05$). $^{A-D}$: Within each row, different superscript uppercase letters show differences between the concentrations within each fiber ($p < 0.05$). $^{X–Z}$: Within each row, different superscript uppercase letters show differences between the storage periods with respect to same fiber type and concentration ($p < 0.05$).

TABLE 3: *Effect of fiber type and concentration on color properties of fried meatballs.*

			Fiber concentration		
	Fiber type	Control (0 %)	4 %	8 %	12 %
L	Wheat	44.79^{aA}	38.44^{bB}	33.24^{cC}	28.78^{cD}
	Cellulose	44.79^{aC}	48.38^{aB}	50.96^{aA}	52.37^{aA}
	Oat	44.79^{aD}	46.80^{aC}	48.51^{bB}	50.76^{bA}
a	Wheat	5.27^{aC}	11.57^{aB}	13.19^{aA}	11.69^{aB}
	Cellulose	5.27^{aC}	3.53^{cD}	7.47^{cB}	8.37^{bA}
	Oat	5.27^{aB}	7.84^{bA}	8.25^{bA}	8.49^{bA}
b	Wheat	19.07^{aA}	17.72^{cB}	14.06^{bC}	11.07^{bD}
	Cellulose	19.07^{aB}	19.71^{bB}	22.47^{aA}	23.23^{aA}
	Oat	19.07^{aD}	21.36^{aC}	21.95^{aB}	22.98^{aA}

$^{a–c}$: Within each column, different superscript lowercase letters show differences between the fiber types within each concentration ($p < 0.05$). $^{A–C}$: Within each row, different superscript uppercase letters show differences between the concentrations within each fiber ($p < 0.05$).

samples was between 6.12–6.20. Yılmaz (2004) observed that the pH of meatballs with 5, 10, 15, 20% rye bran were in the range of 6.02–6.09. They said that the highest pH values were obtained from samples with 10 % and 20 % rye bran. Our results were higher than the ones in these studies due to use of different fibers and storage conditions. In another study, pH values of meat burgers with addition of *Aloe vera* decreased in the end of the 7 days cold storage. Also, our results were similar with Can (2012) who determined that pH values of 5.9–6.4 on the 12th day cold storage of chicken meatballs prepared with thyme oil and they did not exceeded the consumption limit that pointed by Gokalp et al. (1999) as 6.5.

In other studies, Kilincceker and Yilmaz (2016) said that TBA values of chicken meatballs increased during cold storage. Serdaroglu et al. (2005) determined that TBA results of meatballs with legume flours were in the range of 0.67–0.82 mg of malonaldehyde/kg samples at 0th day and 1.99–2.55 mg of malonaldehyde/kg samples at 3rd month at frozen storage (–18 °C). They said that TBA values of samples were within the consumption limits. Cava et al. (2012) found that tomato fiber and beet root fiber reduced lipid oxidation of chicken products. They determined that oxidation had a relation with types and levels of fibers. They reported that TBA values were in the range of 2.03–3.82 mg of malonaldehyde/kg samples at 10th day cold storage. Our results were lower than these values and were at the acceptable level for consumption, reported by Gokalp et al. (1999) range from 0.7 to 1 mg of malonaldehyde/kg samples.

Natural color of fiber and storage can affect color of raw samples. So that consumer preference can be affected during sale (Kilincceker and Yilmaz 2016). Color values of raw chicken meatballs were given in table 2. It understood that cellulose fiber was more advantageous than wheat fiber and oat fiber for *L* and *b* values of raw samples. However, wheat fiber and oat fiber shoved better results than cellulose fiber for *a* values. Generally, addition of fiber increased the *L* and *b* values of raw meatballs. However *a* values decreased with fiber addition. Progressive storage decreased *a* and *b* values of some samples. *L* values of samples with 8 % and 12 % cellulose fiber were higher than other samples as 48.02 and 50.19 in the end of 10th day. Samples with 4 % wheat fiber and 4 % cellulose fiber had higher *a* values as 0.89 and 0.74 at last storage day whereas samples with 8 % and 12 % cellulose fiber have higher *b* values than others as 22.04 and 23.16, respectively (table 2).

In similar studies, Aleson-Carbonel et al. (2005) found that samples prepared with lemon fiber showed differences in color. Cava et al. (2012) said that *L* values of tomato fiber and beet root fiber enriched meatballs are lower than inulin enriched meatballs and control group. In this study, tomato fiber increased the *a* values whereas beet root and inulin fiber decreased the value of raw samples. Color values of samples were in the range of 47.7–67.8 for L, 0.6–13.5 for *a*, and 5.7–37.7 for *b*. Our results were generally lower than the ones in this study. These differences were because of different fibers and levels. Similarly, Kilincceker and Yilmaz (2016) measured that *L* values of raw samples with lemon fiber and pea fiber were higher than other. They said that they also decreased during cold storage.

Similar to raw samples, the color of fried chicken meatballs is important for the consumer. Especially, goldish color is appreciated in such products (Kilincceker 2017). Color values of fried samples are presented in table 3. According to table, it was understood that samples with cellulose fiber had better *L* values than others whereas wheat fiber had higher *a* values than samples with cellulose

Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

fiber and oat fiber. However, *b* values of samples with cellulose fiber and oat fiber were higher than with wheat fiber. Addition of wheat fiber decreased *L* values of samples whereas addition of cellulose fiber and oat fiber increased. The *a* value of samples with wheat fiber showed the fluctuating results with fiber addition and it increased with increase of concentrations for cellulose fiber and oat fiber. Fiber addition decreased *b* values of samples with wheat fiber. However, it increased this value of samples with cellulose fiber and oat fiber. The highest *L* value was on sample surface with 12 % cellulose fiber as 52.37. The highest *a* value was on surface with 8 % wheat fiber as 13.19 whereas samples with 12 % cellulose fiber and 12 % oat fiber had higher *b* values than others as 23.23 and 22.98 (table 3). In similar studies; Kilincceker (2016) reported that natural colors of fibers are important for color of fried chicken meatballs. He said that pea fiber and oat fiber increased the lightness of meatballs. Also, he found that addition of wheat fiber and apple fiber increased *a* values and pea fiber increased *b* values of the samples. Similarly, Yilmaz (2004) determined that 20 % rye bran increased lightness (*L*) of meatballs. He reported that addition of rye bran increased *b* values whereas decreased *a* values of cooked meatballs. In another study, Yasarlar et al. (2007) found that meatballs with bran had lower *L, a* and *b* values than control samples.

TABLE 4: *Effect of fiber type and concentration on technological properties of fried meatballs.*

Technological properties	Fiber type	Fiber concentration Control (0 %)	4 %	8 %	12 %
Frying yield (%)	Wheat	82.25^{aC}	85.20^{bA}	83.81^{aB}	82.64^{abC}
	Cellulose	82.25^{aD}	87.27^{aA}	84.02^{aB}	83.53^{aC}
	Oat	82.25aA	82.23^{cA}	82.10^{bA}	81.85^{bA}
Diameter reduction (%)	Wheat	0.50^{aA}	-2.27^{aB}	-1.99^{aAB}	-1.50^{abAB}
	Cellulose	0.50^{aA}	-0.41^{aAB}	-1.01^{aAB}	-2.32^{bB}
	Oat	0.50^{aA}	0.03^{aA}	-1.97^{aB}	-0.52^{aA}
Penetrometer value (mm)	Wheat	16.64^{aA}	12.50^{bAB}	10.99^{bB}	9.02^{aB}
	Cellulose	16.64^{aAB}	18.85^{aA}	13.57^{aB}	10.39^{aC}
	Oat	16.64^{aA}	16.13^{abA}	10.73^{bB}	6.74^{bC}
Moisture retention value (%)	Wheat	72.52^{aA}	75.32^{aA}	73.26^{aA}	68.87^{aB}
	Cellulose	72.52^{aB}	76.61^{aA}	70.63^{bC}	66.66^{abD}
	Oat	72.52^{aA}	71.31^{bA}	68.79^{bB}	64.10^{bC}
Fat absorption value (%)	Wheat	3.73^{aA}	5.58^{aA}	4.51^{aA}	5.88^{aA}
	Cellulose	3.73^{aA}	4.21^{aA}	5.88^{aA}	5.19^{aA}
	Oat	3.73^{aA}	4.65^{aA}	5.26^{aA}	5.05^{aA}

$^{a-c}$: Within each column, different superscript lowercase letters show differences between the fiber types within each concentration ($p < 0.05$). $^{A-C}$: Within each row, different superscript uppercase letters show differences between the concentrations within each fiber ($p < 0.05$).

TABLE 5: *Effect of fiber type and concentration on sensory properties of fried meatballs.*

Sensory properties	Fiber type	Fiber concentration Control (0 %)	4 %	8 %	12 %
Appearance	Wheat	6.30^{aA}	6.00^{aA}	6.25^{aA}	4.50^{aB}
	Cellulose	6.30^{aA}	5.85^{aA}	5.30^{bA}	5.50^{aA}
	Oat	6.30^{aA}	5.60^{aA}	6.30^{aA}	5.20^{aA}
Color	Wheat	6.40^{aA}	6.10^{aA}	5.95^{aA}	4.35^{aB}
	Cellulose	6.40^{aA}	5.80^{aA}	5.10^{aA}	5.05^{aA}
	Oat	6.40^{aA}	5.20^{aA}	6.35^{aA}	4.25^{aB}
Odor	Wheat	6.60^{aA}	6.60^{aA}	6.40^{aA}	5.70^{abA}
	Cellulose	6.60^{aA}	6.30^{aA}	6.00^{aA}	6.00^{aA}
	Oat	6.60^{aA}	6.00^{aA}	5.85^{aA}	5.50^{bA}
Taste	Wheat	6.65^{aA}	6.70^{aA}	6.15^{aAB}	5.65^{aB}
	Cellulose	6.65^{aA}	5.95^{aAB}	5.35^{aB}	4.45^{aC}
	Oat	6.65^{aA}	6.75^{aA}	5.75^{aAB}	4.70^{aB}
Texture	Wheat	6.65^{aA}	6.75^{aA}	5.30^{aB}	5.50^{aB}
	Cellulose	6.65^{aA}	6.70^{aA}	6.00^{aAB}	4.75^{aB}
	Oat	6.65^{aA}	6.40^{aA}	5.90^{aAB}	4.90^{aB}

$^{a-c}$: Within each column, different superscript lowercase letters show differences between the fiber types within each concentration ($p < 0.05$). $^{A-C}$: Within each row, different superscript uppercase letters show differences between the concentrations within each fiber ($p < 0.05$).

Textural changes during cooking occur by protein denaturation in food, increase fat absorption and cause moisture loss. They also cause shrinking and hardening of product (Cava et al., 2012). Some technological properties of samples prepared with different fibers were indicated in table 4. Generally, it can be said that cellulose fiber was more advantageous for frying yield, diameter reduction and penetrometer value. However, wheat fiber and cellulose fiber had better results than oat fiber for moisture retention whereas fiber type was not important for fat absorption (Table 4). Addition of fiber in meatballs decreased the frying yields for wheat fiber and cellulose fiber. It did not change for oat fiber. Diameter reductions of samples with wheat fiber increased with fiber addition whereas it decreased with cellulose fiber. However, diameters showed fluctuating results in sample with oat fiber at different concentrations. Increasing of fiber concentrations decreased the penetrometer values and moisture retentions whereas it did not have an effect on fat absorptions of fried chicken meatballs. Samples with 4 % wheat fiber and 4 % cellulose fiber had higher frying yields than others as 85.20 % and 87.27 %. Lowest diameter reductions were in samples with 4 % wheat fiber and 12 % cellulose fiber as –2.27 % and –2.32 % after frying. The highest penetrometer value was in sample with 4 % cellulose fiber as 18.85 mm (table 4). Kilincceker and Yilmaz (2016) determined that increase in the amount of apple fiber and lemon fiber causes cracks and decreases yield of chicken meatballs. However, pea fiber leads to avoid hardening and reduces cracks and increases yield. Talukder and Sharma (2010) found that the cooking yield of chicken meat patties prepared with wheat bran and oat bran was affected by bran type and it increased with the bran concentrations increased. In other studies; Sanchez-Zapata et al. (2010) observed that addition of nut fiber increased the cooking yield in pork burger. Soltanizadeh and Ghiasai-Esfehani (2015) reported that *Aloe vera* caused decrease in cooking loss and diameter reductions in beef burgers. *Aloe vera* behaved as a hydrocolloid and supported the quality of samples. Sanchez-Zapata et al. (2010) found that nut fiber decreased diameter reductions of pork burger. Similarly, Mansour and Khalil (1997) said that wheat fiber decreased diameter reductions as compared to control. There is a linear relationship between penetrometer value and moisture content. Samples with 4% fibers had higher penetrometer values than others because of their softer structure. Yasarlar et al. (2007) also reported that the firmness increased with more bran addition in meatballs.

Moisture and fat ratios were factors that affect the texture and calorie of fried food. Frying process decreases moisture content and increases fat content of product. This is an undesirable condition for healthy eating. The manufacturers are trying to solve this problem by using various materials such as fiber (Pinero et al. 2008). The highest moisture retention value was in sample with 4 % cellulose fiber as 76.61 % whereas fat absorption values of samples were in the range of 3.73–5.88 % after frying (table 4).

Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

Ausgabe für imr:livelyzachary

Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

Similarly, Serdaroglu (2006) found that addition of oat flour increased moisture retention values in beef patties. Sanchez-Zapata et al. (2010) observed that nut fiber affected moisture retention of pork burgers. They said that addition of 15 % fiber had higher moisture retention values than 5 % and 10 % fiber in burger. Pinero et al. (2008) also determined that addition of 13.45 % oat fiber in beef patties increased the moisture retention. Similar results were reported by Kurt and Kılıncceker (2012) and Ulu (2006) for moisture retentions. The reduction of moisture retentions by increasing the fiber concentration in the fried samples may be connected with increase in dry matter in total mass. As shown in table 1, the fibers have a very low water content. In other studies, Yasarlar et al. (2007) said that 20 % rye bran decreased the fat content of meatballs after cooking. Santhi and Kalaikannan (2014) reported that increased level of oat flour in cooked chicken nuggets decreased the fat ratios in samples. Mansour and Khalil (1997) stated that beef burgers with wheat fibers had lower fat ratios than control after cooking. In our study, the values of moisture retention were similar to these results whereas the fat absorption were not similar due to different treatments.

The sensory quality of food is an important attribute for the consumers. They affects the salability of the product and the degree of liking during consumption. These features should be evaluated because they are influenced by the physical and chemical properties of the materials in production (Kilincceker 2017). Fiber type was found to be important for appearance at level of 8 % and odor at level of 12 % whereas it did not have an effect on other sensory properties (table 5). Addition of fiber decreased appearance scores at level of 12 % for wheat fiber and the color scores at level of 12 % wheat fiber and oat fiber. Taste and texture results also decreased with fiber addition. Samples with 8 % wheat fiber and oat fiber had higher appearance values as 6.25 and 6.30. Color scores of control and sample with 8 % oat fiber were higher than the others as 6.40 and 6.35. The highest odor score was in sample with 4 % wheat fiber and the control as 6.60. Samples with 4 % wheat fiber and oat fiber had better results than others as 6.70 and 6.75 for taste. The highest texture scores were in sample with 4 % wheat fiber and cellulose fiber as 6.75 and 6.75, respectively (table 5). Generally, sensory scores of fiber enriched meatballs were lower than control group. Especially, they formed hard structure at high fiber levels and decreased the scores of panelists. However, some results are above 6 (like slightly). Similarly, Mansour and Khalil (1997) determined that fiber type affected the sensory quality of beef burgers whereas fiber levels did not affect. Oliveira et al. (2016) reported that apple fiber did not have an effect on some sensory properties of chicken meatballs. Santhi and Kalaikannan (2014) found a decrease in some sensory features with the addition of oat flour in chicken nuggets. Sanchez-Zapata et al. (2010) said that addition of nut fiber in pork burger did not have an effect on sensory qualities. However, there are studies that have positive findings about fiber use in such products (Pinero et al. 2008; Gedekar et al. 2016; Kilincceker and Yilmaz 2016.

Conclusion

It was found that the use of fibers in chicken meatball production can be beneficial. Especially, cellulose fiber and oat fibers more improved the storage stability of samples than wheat fiber. Addition of wheat fiber increased pH values whereas increasing of cellulose fiber decreased TBA values of raw samples. However, addition of fibers increased *L* and *b* values and decreased *a* values of raw meatballs. Storage increased the pH and TBA means whereas decreased *L, a* and *b* values, generally. Cellulose fiber had better effect on color and technological properties of fried meatballs whereas use of different fibers may provide advantages in different ways for sensory properties. Addition of wheat fiber decreased *L* and *b* values of fried samples whereas cellulose and oat fiber increased. Increasing of cellulose fiber in meatballs increased *a* values of fried meatballs. Addition of wheat fiber and cellulose fiber decreased the frying yields whereas fiber addition decreased the diameter reductions, penetrometer values, and some sensory properties of samples. Consequently, it can be said that the use of cellulose fiber at 8 % and 12 % levels is more advantageous than other samples.

Acknowledgements

The authors are grateful to the Adıyaman University Research Fund (TEBMYOMAP/2016-0001; Turkey), İrfan Doğar and Yakup Canpolat (Technical Sciences Vocational School) for their technical and financial support of this research work.

Conflict of interest

In this study, author confirms that there is no conflict of interest.

References

Aleson-Carbonell L, Fernandez-Lopez. JO, Perez-Alvarez JA, Kuri V. (2005): Characteristics of beef burger as influenced by various types of lemon albedo. Innovative Food Science and Emerging Technologies, 6(2), 247–255.

AOAC (2002): Offical methods of analysis (17thed.). Association of official analytical chemists, Washington, DC.

Can ÖP (2012): The Effect of thyme oil on the shelf life of chicken balls during storage period. Slovenian Veterinary Research, 49(1), 19–26.

Cava R, Ladero Cantero L, Ramirez VR (2012): Assessment of different dietary fibers (tomato fiber, beet root fiber, and inulin) for the manufacture of chopped cooked chicken products. Journal of Food Science, 77(4), 346–352.

Dogan IS (2006): Factors affecting wafer sheet quality. International Journal of Food Science and Technology, 41(5), 569–576.

Gadekar YP, Shinde AK, Karim, SA (2016). Effect of inulin on physico-chemical, textural and sensory characteristics of reduced fat lamb nuggets. Veterinary and Animal Sciences, In Press, http://dx.doi.org/10.1016/j.vas.2016.11.002.

Gokalp HY, Kaya M, Tulek Y, Zorba O (1999): Laboratory application guide and quality control in meat and meat products (In Turkish). Atatürk Üniversitesi Ziraat Fakültesi, Yay No: 318, Erzurum, Turkey.

Khalil AH (2000). Quality characteristics of low-fat beef patties formulated with modified corn starch and water. Food Chemistry, 68(1), 61-68.

Ausgabe für imr:livelyzachary
Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.

The contents are protected by copyright. The distribution by unauthorized third parties is prohibited.

Kılınççeker O (2016): Effect of plant based fibers on some physical and sensory properties of chicken meatballs. Yuzuncu Yıl University, Journal of The Institute of Natural & Applied Sciences, 21(2), 68–74.

Kilinceker O (2017): The use of tara, tragacanth and agar agar gums in chicken meatballs. (In Turkish). Gida, 42(3), 75–80.

Kilincceker O, Yılmaz MT (2016): Effects of different plant based fibers on some quality properties of raw and fried meatballs. (In Turkish), Turkey 12. Food Congress, 05–07 Ekim 2016, Trakya Üniversitesi, Edirne. P: 9. (Abstr).

Kurt Ş, Kılınççeker O (2012): The effects of cereal and legume flours on the quality characteristics of beef patties. Kafkas Universitesi Veteriner Fakültesi Dergisi, 18(5), 725–730.

Mansour EH, Khalil AH (1997): Characteristics of low-fat beef burger as influenced by various types of wheat fibers. Food Research International, 30 (3–4), 199–205.

Ockerman HW (1985): pH measurement. In: Quality Control of Post Mortem Muscle Tissue (2nded.). The Ohio State University, Columbus Ohio.

Oliveira JMG, Salgado RL, Costa-Lima BRC, Guedes-Oliveira J, Conte-Junior CA (2016): Washed cashew apple fiber (Anacardium occidentale L.) as fat replacer in chicken patties. LWT – Food Science and Technology, 71(8), 268–273.

Petracci M, Bianchi Mudalal MS, Cavani C (2013): Functional ingredients for poultry meat products. Trends in Food Science and Technology, 33(1), 27–39.

Pinero MP, Parra K, Huerta-Leidenz N, Moreno LA, Ferrer M, Araujo S, Barboza Y (2008): Effect of oat's soluble (ß-glucan) as a fat replacer on physical, chemical, microbiological and sensory properties of low-fat beef patties. Meat Science, 80(3), 675–680.

Sanchez-Zapata E, Munoz CM, Fuentes E, Fernandez-Lopez J, Sendra Sayas EE, Navarro C (2010): Effect of tiger nut fiber on quality characteristics of pork burger. Meat Science, 85(1), 70–76.

Santhi D, Kalaikannan A (2014): The effect of addition of oat flour in low-fat chicken nuggets. Journal of Nutrutional and Food Sciences, 4 (1), 1–4.

Serdaroğlu M (2006): The characteristics of beef patties containing different levels of fat and oat flour. International Journal of Food Sciences and Technology, 41 (2), 147–153.

Serdaroğlu M, Yıldız-Turp G, Abrodimov K (2005): Quality of low-fat meatballs containing legume flours as extenders. Meat Sciences, 70 (1), 99–105.

Soltanizadeh N, Ghiasi-Esfahani H (2015): Qualitative improvement of low meat beef burger using Aloe vera. Meat Science, 99(1), 75–80.

Talukder S, Sharma DP (2010): Development of dietary fiber rich chicken meat patties using wheat and oat bran. Journal of Food Science and Technology, 47 (2), 224–229.

Tarladgis BG, Watts, BM, Younathan MT (1960): A distillation method for the quantitative determination of malonaldehyde in rancid foods. Journal of American Oil Chemists Society, 37(1), 44–48.

Ulu H (2006): Effects of carrageenan and guar gum on the cooking and textural properties of low fat meatballs. Food Chemistry, 95 (4), 600–605.

Yaşarlar EE, Dağlıoglu O, Yılmaz I (2007): Effects of cereal bran addition on chemical composition, cooking characteristics and sensory properties of Turkish meatballs. Asian Journal of Chemistry, 19 (3), 2353–2361.

Yılmaz I (2004): Effects of rye bran addition on fatty acid composition and quality characteristics of low-fat meatballs. Meat Science, 67 (2), 245–249.

Address of corresponding author:
Osman Kilincceker
Department of Food Processing, Technical Sciences Vocational School
University of Adıyaman
TR-02040, Adıyaman
Turkey
okilincceker@adiyaman.edu.tr

Ausgabe für imr:livelyzachary Die Inhalte sind urheberrechtlich geschützt. Eine Weitergabe an unberechtigte Dritte ist untersagt.