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Angerstr. 12
85354 Freising - Germany
Phone: ++49 – (0) 8161-48420
Fax: ++49 - (0) 8161-484248
Email: parlar@psp-parlar.de
www.psp-parlar.de

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ANALYSIS OF DIFFERENT BISCUITS AVAILABLE IN KASHMIR VALLEY, INDIA

Sajad A Sofi, B. N. Dar*, Abida Jabeen and Darakshan Majeed

Department of Food Technology, IUST, Awantipora, J and K, India

ABSTRACT

"Analysis of different biscuit samples available in local markets of Kashmir Valley, India " was carried out. Different types of biscuits from leading manufacturers of the valley (Hat Trick, Jan bakers and Jee Enn Sons) were procured randomly from markets of Srinagar (Kashmir). The samples were tested for physico-chemical, sensory, textural and microbiological properties. The results indicate that biscuits of Hat Trick recorded maximum overall acceptability on a 5-point hedonic scale. On the basis of physico-chemical analysis, it was observed that protein content of biscuits ranged from 8.47 to 12.46%, fat content from 29.60 to 33.66%, crude fibre from 0.66 to 0.90%, ash content from 0.49 to 0.73%, carbohydrate from 51.14 to 55.90%, and moisture content from 1.38 to 4.50%. The biscuits of Hat Trick recorded maximum protein and fat content; crude fibre was highest in Jan bakers biscuits whereas maximum ash, carbohydrate and moisture contents were recorded in Jee Enn Sons biscuits. Calorific value was determined by Atwater factor to observe food energy value in biscuits. The maximum calorific value of 539.84 Kcal/g was recorded in Jan bakers biscuits. In Jee Enn Sons biscuits, maximum spread ratio (1.75) and spread factor (39.30) were recorded. Textural studies showed maximum cutting force (4.45 Kg) for biscuits of Jan bakers. Total plate count carried out in all biscuit samples was under acceptable limits.

KEY WORDS: Hat Trick, Jan bakers, Jee Enn Sons , physico-chemical, calorific value, Atwater factor, spread ratio, spread factor, cutting force, total plate count

1. INTRODUCTION

Biscuits are nutritive snacks produced from unpalatable dough that is transformed into appetizing products through the application of heat in an oven [1]. They are ready-to-eat, convenient and inexpensive food products containing digestive and dietary principles of vital importance [2]. The principal ingredients are flour, fat, sugar and water; other ingredients include milk, salt, flouring and aerating agents [3]. Biscuits are a rich source of fat and carbohydrates; hence, they are energy-giving food but also a good source of protein and minerals [1]. Biscuits are one of the best-known quick snack products, and often referred to as small sweet cakes. They are characterized by a formula high in sugar and shortening but low in water. The terms biscuits and cookies are almost synonymously used in India for the products prepared commercially using refined flour, hydrogenated fats and sugar along with emulsifiers and other additives. However, in the Western world 'biscuit' is a small round bread leavened with baking powder or soda, and the 'cookie' is a small, flat-baked bread, containing milk, flour, eggs, sugar and leavening agents. This food is made from unleavened dough. It is produced from a mixture of flour and water which may contain fat, sugar and other ingredients mixed together into the dough which is allowed to rest for a period; then. it is passed between rollers to make a sheet, and biscuits are convenient snack products dried to a very low moisture content taken among young people and adults to provide energy [4]. Biscuits are the most popular bakery products consumed by a wide range of populations. This is mainly due to its ready-to-eat nature, good nutritional quality and availability in different tastes, longer shelf-life and relatively low costs [5]. Therefore, the alteration of composition of biscuits, directed to enhance their nutritive and/or functional properties, or to enable their consumption by groups of consumers with special needs and demands, has been the subject of interest of many researchers. The basic composition of biscuits enables variety of different possibilities for achievement of dietary properties of the products with respect to type, share and function of three main components for biscuit dough production: flour, fat and sugar [6]. There are different possibilities for development and production of dietary biscuits, from sugar replacement or reduction [7], over alteration of fat shares, composition and properties in biscuits [8], to enrichment of biscuits with different functional components [9]. The bakery industry has been steadily growing in the country, being the largest among the processed food industries. The two major bakery industries, namely, bread and biscuits, account for almost 82 % of the total bakery products. The annual production of bakery products is estimated to be more than 3.0 million tonnes. India is recognized to be the second largest producer of biscuits, next only to the United States of America, with an annual production of 740,000 metric tonnes in 1997-98 which has escalated to 1.714 mill. metric tons dur-

ing 2005-2009 [10]. Among the bakery products, biscuits command wide popularity in rural as well as urban areas among people of all age groups [10]. The production of biscuits in the country, both in the organized and unorganized sectors, is estimated to be around 11 million tons.

Although India is the largest producer of biscuits, paradoxically the per capita consumption of biscuits is as low as 8 kg per annum as against 15 kg per annum in developed countries [11]. It is interesting to note that although biscuits do not belong to the Indian traditional cuisine, they are ubiquitously present in all types of markets of India, which indicates the popularity of these products. Biscuits are available in different unit packages in various flavours, shapes, sizes, and with excellent organoleptic characteristics. Excellent shelf-life at ambient conditions, simplicity and ease of handling during use and transport as well as availability at affordable prices for the diverse consumers make the biscuits popular, even in traditional food cultures of India. Owing to their popularity and ubiquitous presence in Indian markets, the biscuits are important components of one's diet providing nutrients. The biscuits, if modified suitably, are probably the best vehicles to carry the nutrients to meet the nutritional demand of common consumers. There is a growing awareness among the consumers regarding the constituents that affect health both positively and negatively. The number of such health-conscious consumers is fast increasing, and so is the health food industry. New foods like biscuits with new health claims are flooding the market to meet the diverse demands of consumers.

The objectives of this research "Analysis of different biscuit samples available in Kashmir valley " are to study and compare their physicochemical, sensory and textural properties as well as their microbial load.

2. MATERIALS AND METHODS

2.1 Materials

Biscuit samples were procured from the Hat Trick, Jan and JeeEnn Sons bakery industries, and carried to the food technology laboratory for the analysis of various parameters.

2.2 Methods

Proximate analysis of biscuits: Moisture, crude protein, ash, crude fat and crude fibre values of various biscuit samples were determined using AACC methods [12].

Carbohydrates: Carbohydrates were determined by subtracting the moisture, fat, protein, ash and crude fiber from 100%.

Carbohydrates (%) = 100 - (moisture % + fat % + protein % + crude fiber % + ash %)

Calorific Value: Protein, fat and starch contents were determined according to standard procedures. Calorific value was calculated on the basis that fat provides 9 Kcal/g, protein provides 4 Kcal/g, and starch provides 4Kcal/g [13].

Biscuits quality: Diameter, thickness, spread ratio and spread factor of various samples were determined by standard procedure [14].

Sensory properties of biscuits: Sensory properties of biscuits were determined by a semi-trained panel. Each sensory attribute was rated on a 5-point hedonic scale (5 - excellent, 4 -good, 3 - average, 2 - fair, 1 - poor).

Texture analysis of biscuits: Hardness in terms of cutting force using a texture analyzer (TA HD Plus) was calculated using the standard procedure available in the data base of texture analyser for biscuits and cookies.

Microbial evaluation of the biscuits: Microbial evaluation of biscuits was studied in terms of total plate count as described by Emmanuel *et al.* [15].

3. RESULTS AND DISCUSSIONS

The present investigation was conducted to analyze the biscuit samples available in the local market of Srinagar.

3.1 Proximate analysis of biscuits

The proximate chemical composition of biscuits was calculated as per AACC methods [12]. The data in Table 1 and illustration in Fig.1 outline the proximate analysis of biscuit samples. It was found that the biscuit sample from Jee Enn Sons had a higher moisture content than the other two biscuit samples. The mean value of moisture content of the three biscuit samples ranged from 1.38 to 4.5 % (Jee Enn Sons 4.50%, Jan 2.90%, Hat Trick 1.38%) and differed significantly ($P \leq 0.05$). This difference is attributed to different packaging materials used by bakers. Hat Trick biscuits procured from the market was packed in linear low density polyethylene (LLDPE) whereas Jan and Jee Enn Sons biscuits were packed in paper materials.

The total fat content of biscuits is mainly a function of externally added fat during biscuit preparation. The highest value of 33.60% was recorded in Hat Trick sample, followed by Jan bakers (31.40%) and Jee Enn Sons (29.60%). Statistically, the fat content in all the samples differed significantly ($P \leq 0.05$). Fat plays a significant role in the shelf-life of food products and as such relatively high fat content could be undesirable in baked food products. This is because a fat can promote rancidity leading to development of unpleasant and odorous compounds [16].

The protein content of the biscuits was attributed to the wheat proteins and posibly to other protein ingredients (eggs) used in biscuit preparation. The lowest values of 8.47 and 8.97 % were recorded in Jee Enn Sons and Jan bakers biscuits, respectively. Highest value of 12.46% was recorded in Hat Trick biscuits. However, protein contents in Jan and

Jee Enn Sons biscuits wee significantly similar but differed significantly from Hat Trick biscuits.

Baked products have proven to be acceptable carriers of fiber from various sources [17]. Biscuits of Jan bakers showed the highest value (0.9%) of crude fibre, followed by Jee Enn Sons biscuits (0.8%). The lowest value of 0.6% crude fiber was recorded in Hat Trick biscuits. Fibre content in all biscuit samples differed significantly from each other.

The ash content in Jee Enn Sons biscuits was highest (0.73%), lowest (0.49%) in those of Jan bakers, and 0.66% in biscuits of Hat Trick. Hat Trick values were significantly similar with Jan bakers and Jee Enn Sons whereas those of Jan bakers and Jee Enn Sons were significantly different at 5% level of significance.

The total carbohydrate value was determined by difference [14]. Carbohydrate contents between biscuits of Jan and Jee Enn Sons bakeries were not significantly different, but those of Hat Trick. It was observed that the increase in protein, fat, fiber, ash and moisture content levels results in decreasing total carbohydrate levels. The highest value was recorded in biscuits of Jee Enn Sons (55.90%), followed by Jan bakers (55.36%) and Hat Trick (51.30%).

3.2 Calorific value

Calorific value was calculated on the basis that fat provides 9 kcal/g, protein 4 kcal/g, and carbohydrates 4 kcal/g. The term Atwater factor (4×protein, 9×fat, 4× carbohydrates) was used for calculation of calorific value/food energy in biscuits [14]. As evident from Table 2, the highest calorific value of 557.44 kcal/g was observed in biscuits of Hat Trick, followed by Jan bakers (539.84 kcal/g) and Jee Enn Sons (523.88 kcal/g). The greater calorific value observed in Hat Trick biscuits may be due to the high fat content with regard to the other two biscuit samples. Calorific values of all the three biscuits samples differed significantly.

TABLE 1 - Proximate composition* of biscuit samples.

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Crude fiber (%)	Carbohydrates (%)
Hat Trick	$1.38^{a}\pm0.40$	$0.66^{ab}\pm0.31$	$12.46^{b}\pm0.47$	$33.66^{c}\pm1.80$	$0.66^{a}\pm0.52$	$51.14^{a}\pm1.30$
Jan Bakers	$2.90^{b}\pm1.08$	$0.49^{a}\pm0.18$	$8.97^{a}\pm0.99$	$31.40^{b}\pm1.25$	$0.90^{c}\pm0.40$	$55.36^{b}\pm1.84$
Jee Enn Sons	$4.50^{c}\pm0.27$	$0.73^{b}\pm0.30$	$8.47^{a}\pm0.12$	$29.60^{a}\pm1.80$	$0.80^{b}\pm0.40$	$55.90^{b}\pm1.10$

Mean values in the same column bearing the same superscript do not differ significantly ($p \leq 0.05$)
* Mean of triplicate determinations ± standard deviation

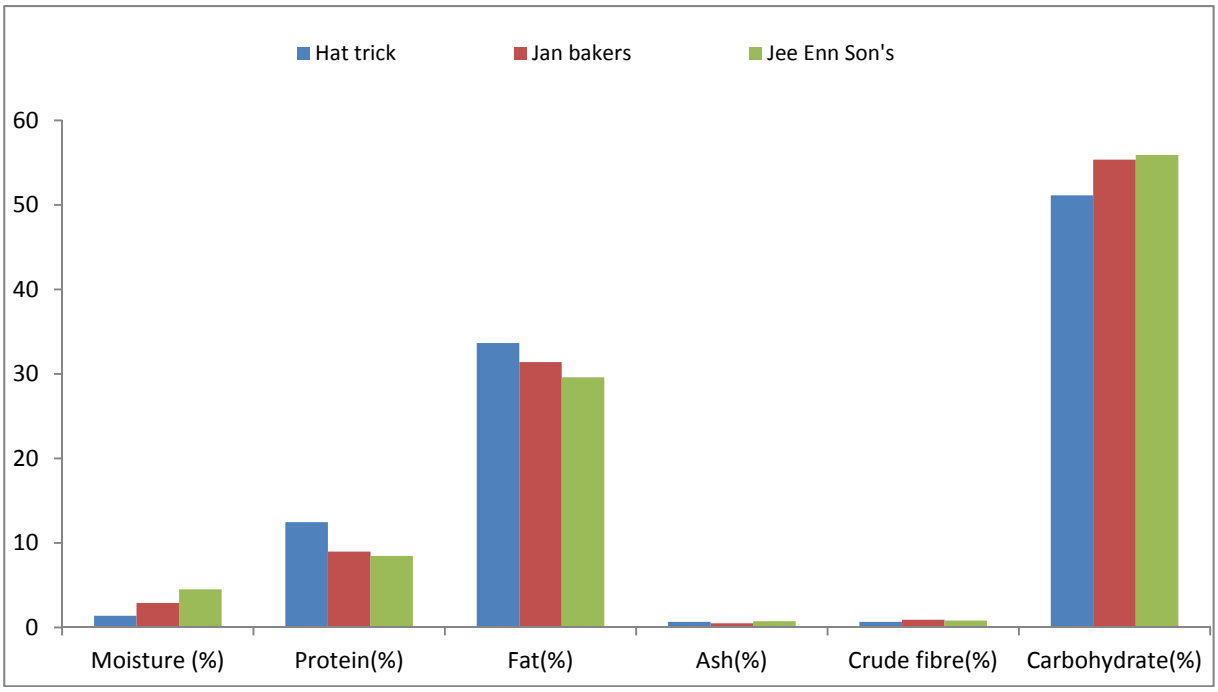

FIGURE 1 - Graphical representation of proximate analysis of biscuit samples.

TABLE 2 - Calorific value* of biscuit samples (kcal/g).

Sample	Fat	Protein	Carbohydrates	Calorific value
Hat Trick	302.40^{c}	49.84^{c}	205.20^{a}	557.44^{c}
Jan bakers	282.60^{b}	35.88^{b}	221.36^{b}	539.84^{b}
Jee Enn Sons	266.40^{a}	3.88^{a}	223.60^{b}	523.88^{a}

Mean values in the same column bearing the same superscript do not differ significantly ($p \leq 0.05$).
* All values are means of triplicates.

TABLE 3 - Physical properties* of biscuit samples.

Sample	Thickness (mm)	Diameter (mm)	Weight (g)	Spread ratio	Spread factor
Hat trick	$3.70^{b}\pm0.25$	$52.60^{a}\pm2.64$	$16.18^{a}\pm0.02$	$1.17^{a}\pm0.02$	$39.30^{b}\pm4.47$
Jan bakers	$3.70^{b}\pm0.25$	$50.50^{a}\pm1.38$	$15.06^{a}\pm0.03$	$1.08^{a}\pm0.02$	$36.60^{a}\pm1.62$
Jee Enn Sons	$10.90^{a}\pm0.26$	$56.80^{b}\pm0.80$	$19.20^{b}\pm0.02$	$1.75^{a}\pm0.04$	$52.00^{c}\pm1.32$

Mean values in the same column bearing the same superscript do not differ significantly ($p \leq 0.05$).
* Means of triplicate determinations ± standard deviation

3.3 Physical analysis of biscuits

Biscuits procured from the local market were evaluated for thickness, diameter, weight, spread ratio, and spread factor. Mean diameter of biscuits was highest (56.80 mm) for biscuits of Jee Enn Sons, followed by Hat Trick (52.60 mm) and Jan (50.50 m). The decrease in diameter of biscuits could be attributed to more flour replacement, and may be due to improper leavening during baking under high fibre content in the procured biscuits but difference in diameter is also due to difference in fibre content as already observed by [17]. Table 3 outlines that biscuit dia-meters of Hat Trick and Jan are significantly similar but those of Jee Enn Sons differ significantly.

Table 3 delineates that same value of 13.7 mm thickness both in Hat Trick and Jan bakers biscuits but minimum and significantly different value of 10.9 mm in Jee Enn Sons. Highest weight of 19.20 g was noticed in Jee Enn Sons biscuits, 16.18 g in Hat Trick and 15.06 g in Jan bakers biscuits. Highest weight was due to increased diameter and thickness. Biscuits of Hat Trick and Jan bakers are significantly the same but significant difference was observed in Jee Enn Sons biscuits. Spread ratio is a value depending on the ratio of weight and thickness. Highest spread ratio was observed in Jee Enn Sons biscuits (1.75), followed by Hat Trick (1.17) and Jan bakers (1.08). Reduced spread ratios of biscuits were attributed to the fact that wheat flour apparently form aggregates with increased numbers of hydrophilic sites available that compete for the limited free water in biscuit dough [18]. Spread ratios of all samples were significantly similar.The spread factor is a ratio depending on diameter and thickness values, and was maximum (52.00) in Jee Enn Sons, followed by Hat Trick (39.30) and Jan bakers (36.60). This reduced spread factor in Hat Trick and Jan bakers biscuits might be due to increase in protein percentage, because protein has more binding power, and thus, it might have reduced spread of biscuits. Also water in the system was insufficient to dissolve sugar during baking which increased the viscosity and the biscuits spread at a slower rate. Statistically, all the biscuit samples differ significantly with each other.

3.4 Sensory properties of biscuits

Mean score for sensory evaluation of biscuits is given in Table 4. Sensory rating of biscuits for appearance showed that Hat Trick sample ranked at the top due its excellent appearance, followed by Jan bakers and least scored Jee Enn Sons samples. Mean score in increasing order was observed in Jee Enn Sons (3.18), Jan bakers (3.68), and Hat Trick biscuits (4.25). In terms of appearance, all biscuits were significantly similar, respectively. Mean score of texture was observed to be 4.25 for Hat Trick biscuits (significantly different), 3.43 for Jan bakers and 3.25 for biscuits of Jee Enn Sons. The mean score of flavour for Hat Trick biscuits earned maximum score (4.12), followed by Jan bakers biscuits (3.00) and minimum score (2.31) for Jee Enn Sons biscuits. Flavour of Hat Trick was significantly different and the same significant difference was observed between biscuits of Jan bakers and Jee Enn Sons .The overall acceptability of biscuits was observed on the basis of quality score evaluation from various attributes like flavour, appearance and texture etc. The mean overall acceptability of Hat Trick sample was highest, followed by samples of Jan bakers and Jee Enn Sons biscuits. Statistically, at 5 % level of significance, overall acceptability of Hat Trick and Jan bakers biscuits was not significantly different.

3.5 Texture analysis of biscuits

Texture analysis in biscuits was measured by hardness measure of biscuits (cutting method as delineated in Fig. 2). Mean highest peak force (4.45 kg) was observed in Jan bakers biscuits, followed by those of Hat Trick (3.4 kg) and Jee Enn Sons (0.85 kg). The difference in peak force among the different biscuits may be due to different moisture content, thickness, and different components in-volved in product formulation. Texture of all the three biscuit samples differ significantly with each other.

TABLE 4 - Sensory perception of biscuit samples.

Sample	Appearance	Texture	Flavour	Overall acceptability
Hat Trick	4.25^{b}±1.03	4.25^{b}±1.16	4.12^{b}±0.58	4.28^{b}±0.70
Jan bakers	3.68^{ab}±0.70	3.43^{a}±0.49	3.00^{a}±0.70	3.65^{b}±0.47
ee Enn Sons	3.18^{a}±0.99	3.25^{a}±0.46	2.31^{a}±0.53	2.70^{a}±0.38

Mean values in the same column bearing the same superscript do not differ significantly ($p \leq 0.05$). *Mean of triplicate determinations ± standard deviation

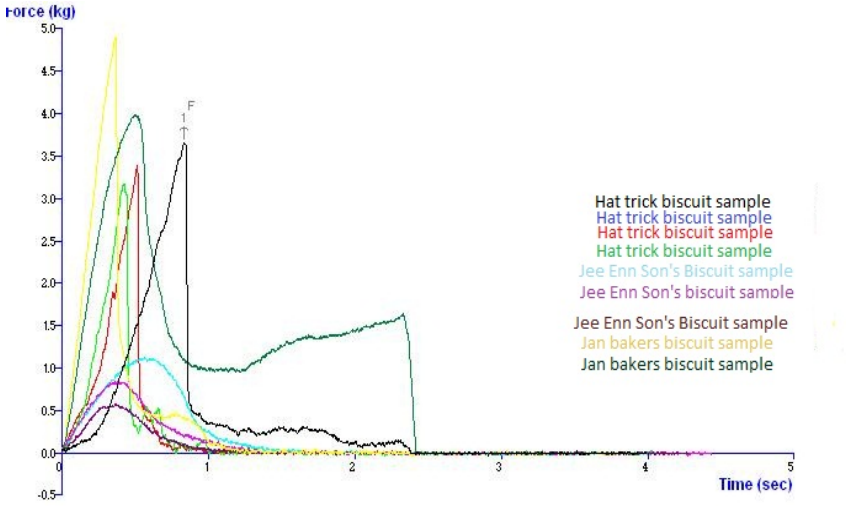

FIGURE 2 - Graphical representation of texture analysis of biscuit samples.

3.6 Microbiological evaluation of biscuits

Mean total plate counts of the microbial load in biscuits samples on nutrient agar media reflect the hygienic conditions in which the biscuit samples were produced [15]. The count can be used to predict the shelf-life or keeping quality of the product. The spoilage of many foods may be imminent when the total plate count reaches 10-100 million per g of product. [16]. The total microbial load on nutrient agar for Hat Trick biscuit sample was 3.33×10^{2}, followed by Jan bakers ($3.86\times10^{2)}$ and 4.84×10^{2} for Jee Enn Son's biscuits. The microbial load of given biscuits samples was compared with the microbiological standards of fortified blended goods (total plate counts < 100,000 cfu/g), and was still within the acceptable value.

4. CONCLUSION

Biscuits play an important role in Indian human diet since they contain naturally high amounts of valuable nutrients like soluble fibres, carbohydrates, proteins, unsaturated fatty acids, vitamins, or minerals, and can give malnourished consumers a nutritious boost. The studies reflected that Srinagar Hat Trick biscuits have the highest acceptability in terms of proximate analysis (protein, fat, moisture), calorific value, sensory perception and microbial load, with regard to Jan bakers and Jee Enn Sons biscuits. The proximate composition changed significantly in all the three samples, and moisture content differed significantly. The texture analysis also revealed different mean cutting force (peak force) in biscuit samples. The microbial load on the biscuit samples was under acceptable range. From the entire work carried out for the "Analysis of different biscuit samples available in local market", it can be concluded that the best biscuit among the three tested is that of Hat Trick in terms of proximate analysis, sensory, texture and microbial load.

The authors have declared no conflict of interest.

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CORRESPONDING AUTHOR

B.N. Dar
Department of Food Technology
Islamic University of Science & Technology (IUST)
Awantipora, Jammu & Kashmir (J and K)
INDIA

E-mail: darnabi@gmail.com

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EFFECT OF BAMIYEH PASTRY FRYING ON QUALITY OF CANOLA AND SUNFLOWER OILS

Jamshid Farmani[1,*], Milad Rezaei[2], Mahroo Esmaeili[2] and Mohsen Mardani[1]

[1] Department of Food Science and Technology, Faculty of Agricultural Engineering, Sari Agricultural Sciences and Natural Resources University, Sari, Iran, PO box 578

[2] Department of Food Science and Technology, Ayatollah Amoli Branch, Islamic Azad University, Amol, Iran

ABSTRACT

Bamiyeh is a deep-fat fried traditional Iranian pastry made from unleavened dough lump with a small ovoid shape and serrated crust. Herein, the effect of Bamiyeh frying on quality of canola and sunflower oils during 17 cycles of repeated frying was investigated. Bamiyeh frying had a small effect on fatty acid composition of oils, the most important changes being a decrease in linolenic acid and an increase in *trans* fatty acids content. With increase of frying cycle, iodine value (IV) of oils de-creased linearly. Frying oils showed an increase in peroxide value (PV), followed by a decrease in the latter cycles of frying which could be expressed using cubic functions. A general linear increase of conjugated dienes value (CDV), percent free fatty acid (FFA), total polar compound (TPC) and refractive index (RI), with increase of frying cycle, was observed for canola and sunflower oils. Lovibond yellow color of oils increased as a natural logarithm function of frying cycle while red and blue color indices increased linearly with frying cycles. Generally, sunflower oil showed higher rates of conjugated diene, TPC and red color formation but lower PV than canola oil. Sunflower and canola oil showed a similar trend and rate of FFA, IV and RI changes. Finally, it was concluded that canola oil may be more oxidatively stable than sunflower oil for repeated frying of Bamiyeh.

KEYWORDS:
Bamiyeh, frying, canola oil, sunflower oil, quality parameters

1. INTRODUCTION

Bamiyeh is a deep-fat fried traditional Iranian pastry which is similar to the doughnut. It is made from unleavened dough lump with a small ovoid shape and serrated crust, which is firstly deep-fried to golden-brown color before being dipped in a sugar syrup. This popular sweet is also produced in India as Jalebi, in Turkey as Tulumba, in Egypt as Balah Al-Sham, and in many other countries in the Middle East and North Africa, like Iraq, Jordan, Syria, Palestine, Lebanon, Tunisia, Algeria, Croatia, Greece, Bosnia, Macedonia, Bulgaria, Serbia and Albania [1, 2].

The quality of frying oil has a lot of influence on the quality of fried food. The fatty acid composition of the frying oil is an essential factor affecting fried food taste, texture, and its shelf-life. Most *trans* fatty acids in fried foods have been proven to come from the oil used and not from the process itself [3]. The repeated use of oil at high temperatures result in thermo-oxidative and hydrolytic reactions which adversely affect the physical, chemical, nutritional and sensory properties of frying oil [4]. During continuous/repeated frying, a stage is reached when the quality of oil/fat deteriorates and properties of oil change to such an extent that production of high quality fried products is not possible anymore, and the oil has to be discarded [5]. Therefore, to keep the quality of fried food constant and to minimize the production cost associated with early disposal/discard of frying oil/medium, it is necessary to monitor the quality of oil during frying process [6].

Proper choosing of frying oil directly affects the quality of fried food. Sunflower oil and canola oil are commonly employed frying media for production of Bamiyeh. However, there is not any information on the effects of Bamiyeh frying on quality of canola and sunflower oils. Also, influences of reactions, such as thermo-oxidative and hydrolytic reactions occurring during frying, have not been evaluated for the production of Bamiyeh. Therefore, the objective of this study was to monitor and compare the quality changes occurring during deep frying of Bamiyeh in pure sunflower and canola oils.

2. MATERIALS AND METHODS

2.1 Materials

All reagents, chemicals and solvents used were from Merck (Darmstadt, Germany). Refined bleached and deodorized canola and sunflower oil containing 100 ppm tertiary butyl hydroxyl quinine were purchased from Partodeneh Khazar (Behshahr, Iran) and stored at 4 °C until use. Other

ingredients including confectionary flour, sugar and eggs were provided from local stores in Amol, Iran.

2.2 Preparation of dough

Two kg of confectionary flour was mixed with 2400 ml of boiling water, and the mix was made into dough in a mixer. The dough was set aside until it became cold. It was then mixed with 50 g of sugar syrup (Brix: 76). Finally, 24 eggs (about 1400 g) were added to the mixture in three stages and the mixing was continued until it became homogenous and smooth. The dough was then cut into a cylinder shape with serrated surface using a spool funnel (average diameter and length of 1.5 and 2 cm, respectively, and 8-10 g each) and placed in the fryer.

2.3 Frying process

Frying was performed in a domestic fryer (model FI7233, DeLonghi, Italy) according to traditional Bamiyeh production methods. At first, the oil was heated to about 80 °C, and then 40-50 pieces of Bamiyeh (400 g) were added into the fryer. The fryer was set on 180 °C and frying was continued until the color of Bamiyeh became golden brown. At the end of frying, the fryer was turned off, fried pastries were removed, and heated oil was allowed to cool to about 80 °C. To start a new cycle of frying, 80 ml of fresh oil was added to the remaining oil in the fryer (to retrieve the absorbed oil by Bamiyeh) and frying was performed as above. Oil samples were drawn at cycles 1, 3, 5, 7, 9, 13 and 17, and stored in the dark in a refrigerator for further analysis.

2.4 Fatty acid composition

Fatty acid methyl esters were prepared according to AOCS Ce 2-66 method [7], and analyzed by a Trace GC (Thermo Finnigan, Italy) according to AOCS Ce 1-91 method [7]. The capillary column was BPX-70 (60 m × 0.25 mm × 0.25 μm) and the detector was a flame ionization detector. Injector and detector were set at 250 °C. Injection was performed in a split ratio of 1:80 and the oven was kept at 175 °C. Nitrogen was used as carrier gas with a flow-rate of 0.8 ml/min.

2.5 Iodine value

Iodine value (IV) was determined according to the AOAC Official Methods 920.158 (Hanus method) [8].

2.6 Peroxide value

Peroxide value (PV) was determined by AOCS Official Method Cd 8-53 [7].

2.7 Free fatty acids

Free fatty acid (FFA) content as percentage of oleic acid was determined by AOCS Official Method Ca 5a-40 [7].

2.8 Conjugated diene value

This index was measured spectrophotometrically (UV 2100, USA) at 234 nm and read against HPLC-grade hexane as blank. The oil sample was diluted to 1:600 with hexane [9]. Finally, conjugated diene value (CDV) was calculated according to the following formula, in which A is the dilution of hexane. An extinction coefficient of 29000 mol/L was used to quantify the concentration of conjugated dienes formed during the frying process [9].

$$CDV = (A \times 600 \times 1000)/29000$$

2.9 Refractive index

An Abbe refractometer model RMT (Atago Co, Tokyo, Japan) was used for measuring the refractive index (RI) at 25 °C, according to AOCS Method Cc 7-25 [7].

2.10 Determination of total polar compounds

The percent (w/w) total polar compounds (TPC) content was determined via column chromatography using silica gel 60 (63–100 μm) as stationary phase and toluene as eluent according to the economical micro-method developed by Schulte [10].

2.11 Color measurement

Color of the oils was determined using a Lovibond tintometer (model E, Salisbury, England) according to AOCS Method 13e-92 [7].

2.12 Statistical analysis

Experiments were performed in a completely randomized block design and analyzed using SPSS version 19.0 (SPSS Inc. Chicago, IL, USA). Pearson bivariate correlation coefficients were calculated using SPSS software. The whole experiment was repeated at least two times and differences between means were compared by Duncan's test at $p<0.05$ level of significance.

3. RESULTS AND DISCUSSION

3.1 Fatty acid composition

During frying, fatty acid composition of frying oils changes due to polymerization, cyclization and pyrolytic, hydrolytic, oxidative, and other chemical reactions promoted by deep frying [11]. Fatty acid composition of oils during Bamiyeh frying is summarized in Table 1. Bamiyeh frying had a small effect on fatty acid composition of canola and sunflower oil. The most important (but small) changes observed were a decrease in linolenic acid and an increase in *trans* fatty acid contents which are in agreement with the work done by other researchers [6, 12-16]. The increase in the amount of *trans* fatty acids during frying has been attributed to the isomerization of PUFAs, mostly linoleic and linolenic acid [13]. It is worth mentioning that the amount of *trans* fatty acids still remained in small amounts (<0.6 %), even after 17 cycles of frying. Ali *et al.* [14] also found a low amount of *trans* fatty acids in canola oil after deep frying of chicken nugget. Because of the slight changes, it seems that the Bamiyeh frying is a mild frying process compared to other frying processes.

3.2 Peroxide value (PV)

In order to evaluate the oxidative changes in oil samples during Bamiyeh frying, PV was determined and presented against frying cycles in Fig. 1. As can be seen in Fig. 1, the correlation between PV of oils and frying cycles could be expressed using cubic functions with high coefficients of determination (R^2>0.92). Generally, with increase of frying cycle, frying oils showed an increase in PV, followed by a decrease in the latter cycles. Previous studies have also reported initial PV increase in vegetable oils during frying, followed by a later decrease [15, 17-19]. In fact, peroxides are the primary oxidation products, so the oxidation process of oils is initially characterized by increased PV. However, peroxides are later converted to secondary oxidation products, such as aldehydes and ketones, which accompany a decrease in PV of the oxidized oil [15]. Generally, canola oil showed higher PV at all cycles of frying as compared to sunflower oil. This may be due to the higher content of linolenic acid and PV of the initial canola oil (compared to that of sunflower oil). In fact, higher content of linolenic acid and peroxides may promote the oxidation process [20]. Talpur *et al.* [12] have also reported higher PV increase in canola oil than sunflower oil, during chicken frying. Though PV of canola oil was higher than that of sunflower oil at all cycles of frying, both oils showed an almost similar peroxide formation behavior. Maximum PV was observed at the 13th cycle of frying for both oils (Fig. 1).

The PV of canola and sunflower oil exceeded the acceptable level of 5 meq/kg of PV determined by the Iranian National Standards Organization standard No 4152 [21], after 9 and 13 cycles of frying, respectively. However, during 17 cycles of frying, PV of oils did not exceed the acceptable level of 10 meq/kg determined by the German Food Codex for edible fats and oils [22].

3.3 Conjugated dienes value (CDV)

The CDV is an appropriate classical index of primary oxidative changes in oils and fats under frying conditions. The evaluation of CDV in frying oil is very important for determining fried food quality because these compounds

TABLE 1 - Effect of Bamiyeh frying on fatty acid composition of sunflower and canola oils

Cycles	Sunflower oil			Canola oil		
	Fresh oil	Cycle 9	Cycle 17	Fresh oil	Cycle 9	Cycle 17
C16:0	7.1	6.9	6.5	4.2	4.3	4.3
C18:0	3.4	3.3	3.2	2.1	2.0	2.1
C18:1	24.8	25.2	25.6	56.1	56.8	56.9
C18:2	61.2	61.5	62.4	27.1	26.7	26.9
C18:3	1.8	1.4	0.4	8.1	7.5	7.1
trans	0.4	0.5	0.5	0.4	0.6	0.6
Saturated	10.5	10.2	9.7	6.3	6.3	6.4
Uusaturated	87.8	88.1	88.4	91.3	91	90.9

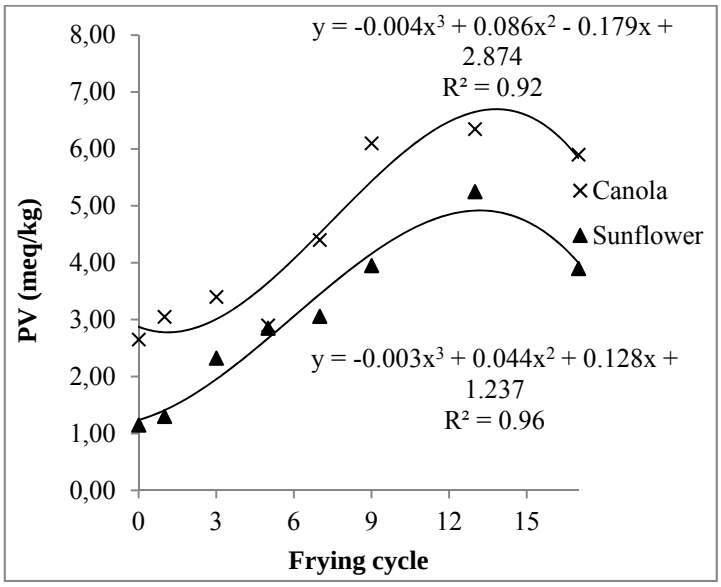

FIGURE 1 - Changes in peroxide value (PV) of canola or sunflower oil during Bamiyeh frying.

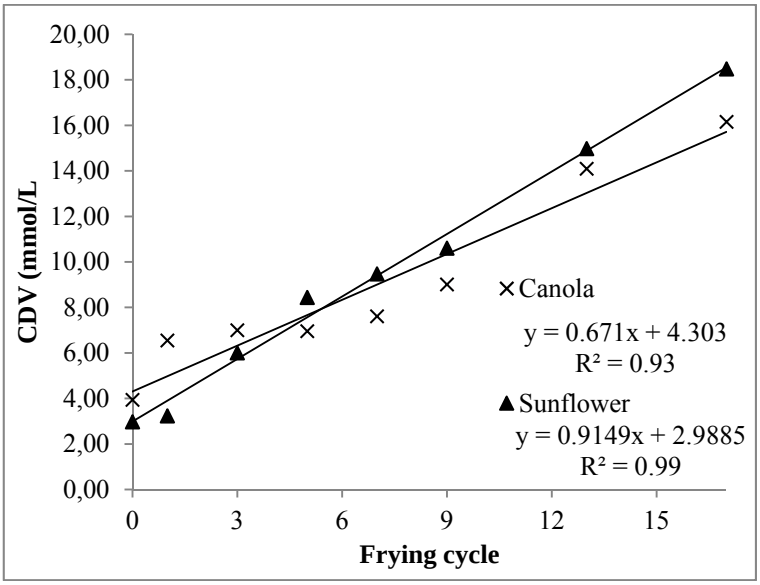

FIGURE 2 - Changes in conjugated diene value (CDV) of canola or sunflower oil during Bamiyeh frying.

often reduce the nutritional value of fried food and cause unpleasant and rancid aromas [17]. The CDVs of oils throughout the frying process are shown in Fig. 2. A general increasing trend of CDV with increasing the frying cycle was observed for canola and sunflower oils. Linear regressions could properly (R^2>0.92) describe the effect of frying cycle on CDV (Fig. 2). Considering the slope of CDV curves, the trend of CD formation in sunflower oil was sharper than that in canola oil. This may be due to the presence of higher amount of PUFAs in sunflower oil than canola oil (Table 1). In fact, the higher the percentage of PUFAs in the oil, the higher the levels of CD formed during frying [23]. Farhoosh and Moosavi [17] also reported an increase of CDV during frying of potatoes with various vegetable oils (individually or as blends). Yaghmar *et al.* [23] reported a similar trend of CDV increase with time in argan, olive and cottonseed oils during frying process of french potatoes.

3.4 Free fatty acids (FFAs)

The amount of FFAs in oils can be used to indicate the extent of oxidative and thermal degradation taking place in unsaturated fatty acids. In addition, hydrolysis of triacylglycerols causes an increase in FFAs which can be provoked by infusion of moisture from the food into the oil during frying process [24]. Figure 3 shows the FFAs (% as oleic acid) content of oils in different cycles of Bamiyeh frying. As refined, bleached and deodorized oils were used in this study, the initial FFA content of oils was very low, and entirely within the legal limits for vegetable oils, as defined by Codex Standard 210 [22].

Repeated cycles of Bamiyeh frying caused a linear increase in FFA content of canola and sunflower oil (R^2 > 0.91). A similar FFA formation trend with no significant difference was observed in canola and sunflower oil (Fig. 3). Other studies have also concluded similar results regarding the steady increase of FFA content during heating of chicken nugget [14], groundnut [25] and mustard [26] oils. However, frying of Bamiyeh caused lower production of FFAs compared to the frying of chicken nuggets [14]. The reason may be due to the difference in composition of food materials and intensity of the frying process which may affect the degradation of the oils in a different way.

Considering the limits of internationally established laws, final FFAs levels found in used oils (0.16 % for canola and 0.17 % for sunflower oil) were in agreement with the law of the countries such as Australia, Belgium, Japan (which establish the limit of 2.5 %), the Netherlands (4.5%), the United States (1 %) [27, 28], and Iran (1%) [21].

3.5 Iodine value (IV)

Effect of Bamiyeh frying on IV of canola and sunflower oils during different cycles of frying is presented in Fig. 4. As can be seen, similar linear decreasing trends of IV (R^2 > 0.88) with almost similar rate were observed in oils during frying. Talpur *et al*. [12] also reported that the IV of sunflower, soybean and canola oils was decreased with respect to the time of frying of chicken which supports the result of this study. Similar results were also reported by Ali *et al.* [14] in frying of chicken nugget with canola oil, and by Manral *et al.* [16] in frying of fish with sunflower oil. The decrease in IV with the increase of frying cycles could be attributed to the changes in fatty acid composition and destruction of double bonds by oxidation, and polymerization taking place throughout frying [29].

3.6 Refractive index (RI)

Changes of RI in the oils with increase of frying cycle are also shown in Fig. 4. RI values of oils were slightly increased as cycle of frying of Bamiyeh increased. The

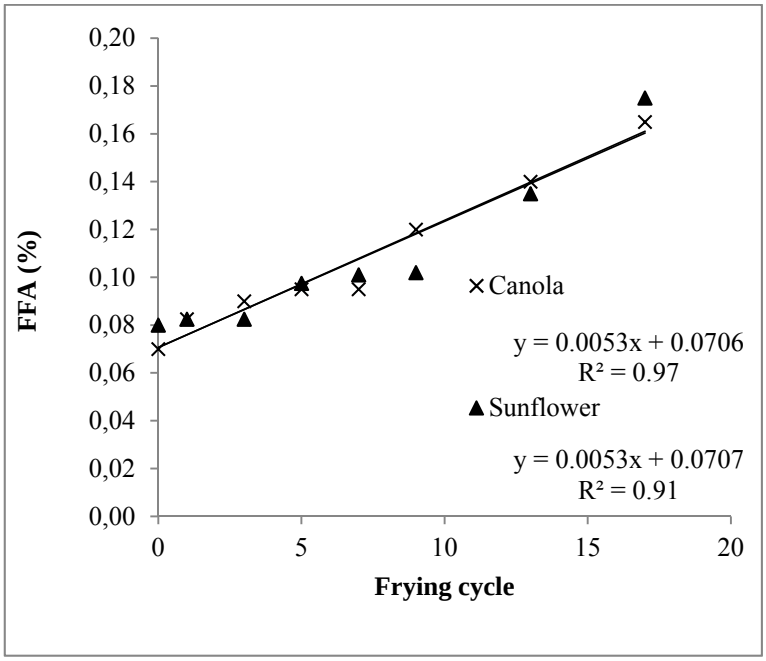

FIGURE 3 - Changes in free fatty acids (FFA) of canola or sunflower oil during Bamiyeh frying.

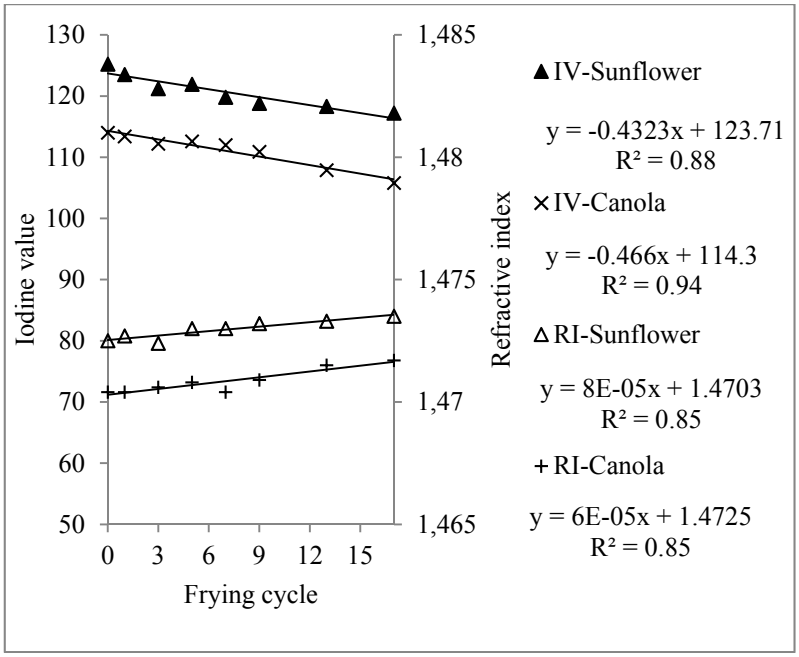

FIGURE 4 - Changes of iodine value (IV) and refractive index (RI) of canola or sunflower oils with increase of frying cycles.

phenomena could be described using linear regressions with $R^2 = 0.88$ (Fig. 4). The slight increment of RI was also supported by the work done on vegetable oils by other scientists [6, 16]. RI increases with an increase in polymerization, saturation of carbon-carbon double bonds, molecular cohesiveness, and existing of moisture in food [30]. Total increment of RI value after 17 cycles of frying was found to be almost similar in canola and sunflower oil.

3.7 Total polar compounds (TPCs)

Formation of polar compounds is strongly related with the primary and secondary oxidation during frying and provides the most reliable evaluation of the extent of deterioration in frying oils [31]. Figure 5 illustrates the changes in the percentage of TPC throughout the frying cycles. Fresh oils had a TPC content ranging from 3.1 to 3.7 % reflecting the good quality of these oils, as the TPC content of unused

oils normally range between 0.4 and 6.4 % [32]. As shown in Fig. 5, frying process caused significant ($P<0.05$) and gradual increase in TPC, which could be described as good linear functions of frying cycle ($R^2 > 0.92$). Earlier studies [16, 33] have also reported an increase in TPC with increase of heating/frying time which is in agreement with our findings. The rate of polar compounds formation was higher in sunflower oil than that in canola oil (considering the slope of the linear TPC curves). After 17 cycles of frying, the final TPC levels were found to be 15.2 % in canola and 19.0 % in sunflower oil, which are below the limits (25 %) adopted for the disposal of frying oil as mandatory in several countries [27]. It seems that the Bamiyeh frying is a milder frying process compared to other frying processes, as faster increase in TPC levels was observed when chicken nuggets [14] were fried.

According to TPC analysis of oils, it was observed that the use of high-oleic canola oil was more appropriate than the use of sunflower oil for Bamiyeh frying. In a similar

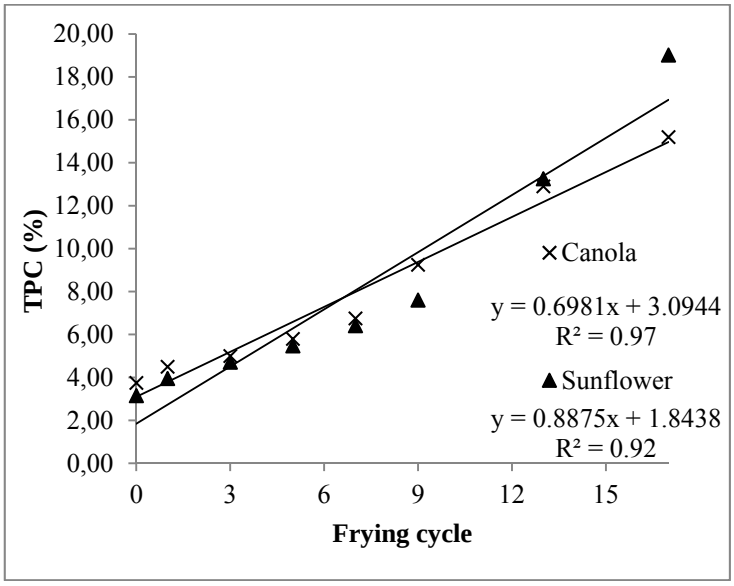

FIGURE 5 - Changes in total polar compounds (TPCs) of canola or sunflower oil during Bamiyeh frying.

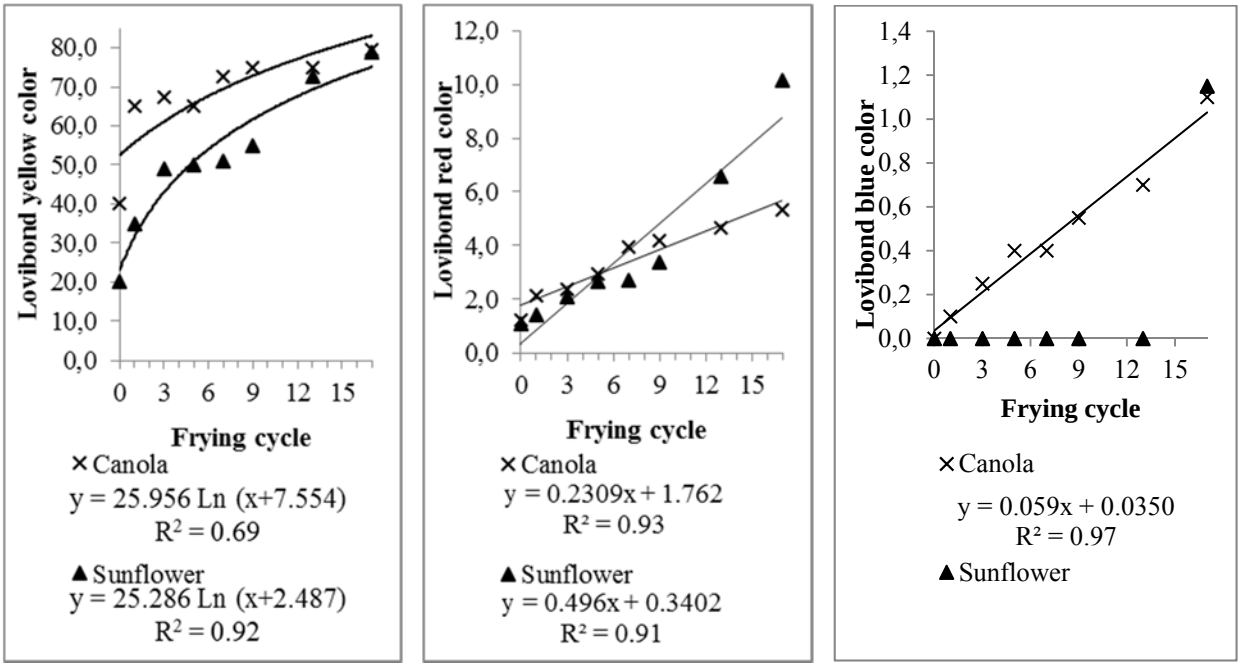

FIGURE 6 - Changes in color of canola or sunflower oil during Bamiyeh frying.

study [34] high-oleic corn oil (containing 65 % oleic acid) showed significantly lower TPC level after 20 h of potatoes frying at 190 °C, compared to normal or hydrogenated corn oils.

3.8 Color

Color change reflects an overall chemical degradation and polymerization in frying oils and shows the extent of oil deterioration caused by oxidation. Accumulation of non-volatile decomposition products, such as oxidized triacylglycerols and FFAs, increase the color intensity of oil [15, 23]. According to Fig. 6, it was observed that the yellow, red or blue color indices of both oils increased with increase of frying cycle. The increase of yellow color of oils could be described as a natural logarithm function of frying cycle ($R^2 > 0.69$, Fig. 6). In other words, a sharp increase in yellow color in the first two cycles of frying with a subsequent slow increase in later cycles was observed for both oils. Though the initial yellow color of sunflower oil was lower than that of canola oil (almost half), it was found to be more than canola oil at the end of the frying cycles. Unlike yellow color index, red and blue color indices showed linear regressions with frying cycles (Fig. 6). Generally the rate of red color appearance in sunflower oil was higher than that of canola oil, and it had higher red color indices than canola oil after 17 cycles of frying. Unlike canola oil which showed a gradual increase in its blue color, sunflower oil resisted against blue color formation till the 13th cycle. The facts that canola oil contains more chlorophyll than sunflower oil [35, 36], and that chlorophyll and its derivatives are one of the main causes of dark color of oils [31], may describe faster dark (blue) color formation in it.

Several reasons were reported in literature for the darkening of oil color caused by heating. Oxidation of the color pigments during frying [31], degradative processes, such as formation of hydroperoxides, conjugated dienoic acids, ketones and hydroxides [31], polymerization reactions at high temperatures [24], presence of suspended charred particles [31], formation of colored material (such as Maillard reaction products) and absorption of color from the fried food [29] could be the reasons describing color change.

3.9 Correlation between quality parameters

To investigate the correlation between quality parameters, Pearson correlation coefficients between binary combinations of parameters were calculated and are presented in Table 2. Pearson correlation coefficient depicts the basic relationship across two variables. The correlation coefficient lies between -1 and +1. If the two variables tend to increase together, the correlation coefficient will be positive. Conversely, if one variable tends to increase as the other decreases, the correlation coefficient will be negative [37]. All binary combinations of parameters, except those containing IV, showed positive Pearson correlation coefficient. IV showed negative Pearson correlation coefficient with all other parameters. As discussed previously, except IV which decreases during frying, all other parameters increase. Parameters having the main negative correlation with IV, were PV and Lovibond yellow color. In fact, one of the consequences of peroxide formation is the loss of double bonds which leads to IV drop [29]. A positive correlation between PV and FFA, CDV, TPC or Lovibond color indices with similar weight was observed. FFA content and CDV were the main factors positively correlated with TPC. In fact, FFAs are of polar compounds in oils and fats; therefore, increase of FFA will be reflected in increase of TPC. CVD was mainly correlated with TPC, FFA and Lovibond red color. Lovibond red color of oils was mainly affected by TPC, CDV and FFA content (Table 2). Increase of conjugated dienes, shifts the maximum wave length of

TABLE 2 - Pearson correlation coefficients between quality parameters of canola or sunflower oil during 17 cycles of Bamiyeh frying.

Parameter	PV	FFA	CVD	TPC	IV	Lovibond color		
						Red	Yellow	Blue
PV	1	0.717(0.002)	0.740(0.001)	0.714(0.002)	-0.761(0.001)	0.603(0.013)	0.844(0.000)	0.615(0.011)
FFA	0.717(0.002)	1	0.956(0.000)	0.986	-0.430(0.096)	0.912(0.000)	0.719(0.002)	0.836(0.000)
CVD	0.740(0.001)	0.956(0.000)	1	0.965(0.000)	-0.414(0.111)	0.914(0.000)	0.763(0.001)	0.712(0.002)
TPC	0.714(0.002)	0.986(0.000)	0.965(0.000)	1	-0.418(0.107)	0.951(0.000)	0.731(0.001)	0.807(0.000)
IV	-0.761(0.001)	-0.430(0.096)	-0.414(0.111)	-0.418(0.107)	1	-0.292(0.272)	-0.767(0.001)	-0.656(0.006)
Lovibond color								
Red	0.603(0.013)	0.912(0.000)	0.914(0.000)	0.951(0.000)	-0.292(0.272)	1	0.728(0.001)	0.734(0.001)
Yellow	0.844(0.000)	0.719(0.002)	0.763(0.001)	0.731(0.001)	-0.767(0.001)	0.728(0.001)	1	0.713(0.002)
Blue	0.615(0.011)	0.836(0.000)	0.712(0.002)	0.807(0.000)	-0.656(0.006)	0.734(0.001)	0.713(0.002)	1

Abbreviations: PV, peroxide value; FFA, free fatty acids; CDV, conjugated dienes value; TPC, total polar compounds; IV, iodine value.
Values in parenthesis represent correlation significance.

absorption to higher regions, and will led to the appearance of sharper red color [38]. Lovibond yellow color showed the highest correlation with PV. The other parameters had an almost similar correlation with yellow color. The most important parameters influencing Lovibond blue color were TPC and FFA content.

4. CONCLUSION

Analysis of quality parameters of sunflower and canola oil revealed that the quality of frying oils was deteriorated with the increase of frying cycles. Generally, FFA content, PV, CDV, TPC, RI and color of sunflower and canola oil increased, while IV decreased. Bamiyeh frying had a small effect on fatty acid composition of oils, the most important changes being a decrease in linolenic acid and an increase in *trans* fatty acids content. Generally, CDV, TPC and Lovibond red color was higher in sunflower oil. However, the trend and rate of FFA, IV and RI changes in sunflower and canola oils were similar. Finally, it was concluded that canola oil may be more oxidatively stable than sunflower oil for repeated frying of Bamiyeh.

When using Pearson correlation analysis, it was possible to correlate different parameters with each other. The most important correlations were found to be negative correlation between IV and PV or Lovibond yellow color, positive correlation between PV and FFA, CDV, TPC or Lovibond color indices, positive correlation between TPC and FFA content or CDV, positive correlation between CVD and TPC, FFA or Lovibond red color.

Despite physicochemical changes, which the oils underwent during this operation, the results of this study have shown proper performance of canola oil under real domestic frying conditions due to its better oxidative stability.

The authors have declared no conflict of interest.

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CORRESPONDING AUTHOR

Jamshid Farmani
Department of Food Science and Technology
Faculty of Agricultural Engineering
Sari Agricultural Sciences and Natural Resources University
PO box 578.
Sari, Iran

Phone/Fax: +98 11 33687718
E-mail: jamshid_farmani@yahoo.com

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UTILIZATION OF SWEET LUPINE IN UNTRADITIONAL PRODUCTS MANUFACTURING

Eman M. Salem, Ayat E. Rizk and Nasra A. Abd-Elhak

Food Technology Research Institute, Agricultural Research Center, Giza, Egypt

ABSTRACT

The aim of this study was utilization of the sweet lupine powder which had nutritional and healthy values. Main objective was supplementation of food products by use of sweet lupine powder and their products in different percentages studying the effect of supplement on nutritional value and sensory evaluation. Lupine protein isolates were prepared by alkaline extraction at pH 9.0, followed by acidic precipitation. Emulsion capacity, stability of lupine powder, isolates and sweet lupine dickstriz showed significant differences. Foaming capacity and foam stability of lupine protein isolate tested was also higher than that of lupine flour and lupine dickstriz . Generally, all samples were acceptable for the sensory evaluation panelists. Highest significant protein, fiber and ash contents were noticed in nuggets prepared from 50% lupine dickstriz with regard to those found in nuggets prepared from chicken meat (control) and tested nuggets (10 and 25%). The protein isolate was of higher digestibility than sweet lupine powder and lupine dickstriz . In addition, extrusion cooking resulted in an increase of protein digestibility, in comparison to raw lupine.

KEYWORDS: Lupine protein isolate, extrusion cooking, sensory evaluation, functional properties

1. INTRODUCTION

Legumes play an important role in human nutrition, since they are rich sources of protein, calories, certain minerals and vitamins. In African diets, legumes are also the major contributors of protein and calories for economic and cultural reasons [1]. Lupine is a good source of nutrients, not only for proteins but also for lipids, dietary fiber, minerals and vitamins [2]. Lupine (*Lupineus albusL.*) seed is mentioned in the ancient and traditional pharmacopoeia books as an anti-diabetic product [3], and they demonstrated that the active protein responsible for the claimed anti-diabetic effect of the lupine seed is effective in man [4]. Lupine flour is widely considered as an excellent raw material for supplementing different food products due to its high protein content, and is largely used as egg substitute (for example, in cakes, pancakes, biscuits, brioche; added to spaghetti, pasta, crisps and bread). Extrusion cooking is a high-temperature, short-time process in which moistened, expansive, feed materials are subjected to mixing, shearing and heating under high pressure, followed by forcing the extrude through a die [5]. During this process, the feed undergo chemical reactions and molecular transformations which could be positive, if nutrient availability is enhanced, or negative, if nutrients are destroyed or altered to become resistant to digestion. Extrusion may influence the nature of feed components by changing physical (e.g. particle size), chemical (e.g. starch gelatinization, inactivation of anti-nutrients), and nutritional (e.g. nutrient digestibility) properties [6]. Heat processing, in general, improves the nutritive value of legume proteins, by inactivating trypsin and growth inhibitors [7]. In general, defatted protein isolates improve sensory profiles; thus, they could be considered as being good for acceptance, keeping the high functionality of the final products unchanged [8]. Lupine powder and isolates can be in cakes, burgers and nuggets. Moreover, protein isolate produced from lupine seeds can be utilized for milk and meat imitation products.

Therefore, the present work was carried out to utilize the sweet lupine powder and its products as a substitute for chicken products, eggs and milk products, and for making high protein and low carbohydrate nuggets or cream caramel.

2. MATERIALS AND METHOD

2.1 Materials

Sweet lupine seeds (*Lupineus albusL.*) were obtained from the local market. Chicken meat, onions, garlic, starch, black pepper, bread crust powder and salt were used as raw material for nuggets production and also obtained from the local market at Giza, Egypt. Sugar, vanilla, milk, lemon and eggs were used as raw materials for cream caramel production and bought at the local market of Giza, Egypt.

2.2 Methods

2.1.1 Preparation of lupine protein isolate

The protein isolate was prepared by isoelectric precipitation method described elsewhere [9]. The pH of the alkaline extraction was 8.5, and the precipitation of protein process was done at pH 4.5, followed by centrifugation at

4000 rpm for 20 min. The precipitated residue was washed several times with deionized water and kept at 4 °C in the refrigerator until use.

2.1.2 Preparation of lupine protein dickstriz

Lupine flour was passed through a 35-mesh sieve (425 microns). The milled lupine flour was individually extruded in the central lab, Faculty of Agriculture, Suez Canal University, using a Bra bender single-screw extruder, No 186501, type 832500, equipped with a feeding screw AEV 300, No 141923, type GNF 1014/2, a speed control of the feeding device, temperature regulators for 2 extruder zones, and a die head, No 186555, type 625415. This device was used to prepare the extrudates from lupine protein isolate. The extrusion process was carried out at the following conditions: the three zones temperature (from the feeding zone to die end) were 90,150 and 200 °C, the screw speed was 249 min^{-1}, the feeding screw speed was 160 min^{-1}, the screw compression was 4:1, the rounded die diameter was 3 mm, and the moisture content of the feeding material was adjusted to 18% by adding the appreciated amounts of water. The quantity of water was added during stirring by a laboratory mechanical stirrer. Lupine protein dickstriz was tempered by leaving it in polyethylene bags at room temperature for 5 h until moisture equilibration, and then, the tested flour was extruded under the above-mentioned conditions. The resultant extrudate was directly dried in a forced air drying oven at 110 °C for 5 min, and allowed to reach the room temperature.

2.1.3 Preparation of nuggets

Chicken meat has been replaced with lupine dickstriz rates of 10, 25 and 50% for nuggets production. Chicken meat was cleaned from skin (chicken) and bones, then cut into small cubes of approximately 2 cm^3, and then minced. Afterwards, the minced chicken meat was mixed with sweet lupine dickstriz, onions, garlic, black pepper, salt and starch. After that, the samples were coated with bread crust powder. Coated and breaded nuggets were coated at a freezer, placed in aluminum foil, and stored for approximately 6 h. The frozen samples were removed from the freezer, and then fried for 2-3 min, until the color was light-yellow [10].

2.1.4 Preparation of cream caramel

Sweet lupine protein isolate was separately blended with eggs at different levels (25, 50, 75 and 100%) for cream caramel production. Then, sugar was put into water at low heat and under stirring until the sugar was dissolved. Then, it was mixed with the egg-blended lupine protein isolate, and hot milk was added under stirring. The filtered components were sieved with a wire sieve, vanilla was added, and the mixture was poured into a freezer paper-lined mold with caramel.

2.2 Methods of analysis

2.2.1 Chemical composition

Moisture content, crude protein (Kjeldahl method), crude fat, crude fiber, and ash of the tested samples were determined according to [11] (% carbohydrates = 100 – (% fat + % ash + % crude fiber+ % crude protein).

2.2.2 Caloric value (kcal)

The calorific value of the samples was estimated in (kcal/g) by multiplying the percentages of crude protein, crude fat and carbohydrate with the recommended factors (4, 9 and 4, respectively) as proposed by[12].

2.2.3 Functional properties

2.2.3.1 Emulsifying activity (EA)

The method employed by [13] was used to evaluate emulsifying activity (EA). A 1% lupine protein suspension was made in distilled water. The pH of the suspension was adjusted to 2, 4, 6 and 8 with 0.1M NaOH or 0.1M HCl in order to study the effect of pH level on the EA of the protein isolates. The protein lupine suspension (100 ml) with a specific pH level was homogenized using a Polytron PCU-2 homogenizer (Switzerland) for a period of 10 min. At the 5th min, 100 ml of oil was added gradually to the suspension with continuous stirring. The emulsion was later centrifuged at 500xg for 10 min in a Hettich Universal 16 centrifuge (Germany). Volume of the emulsified layers was recorded to calculate EA, based on the following formula:

EA (%) = [volume of emulsified layer (ml)/total volume of suspension (ml)] x 100

2.2.3.2 Emulsion Stability (ES)

Sample preparation for the determination of emulsion stability (ES) was similar to that of EA, with an additional step of heating before centrifugation [13]. The emulsion was heated in a Ratek WB 20 water-bath (Boronia, Victoria) at 85 °C for 30 min, and then cooled under running tap water for 5 min to room temperature (20±2 °C). Samples were centrifuged at 500xg for 10 min in a Hettich Universal 16 centrifuge (Germany) before the volume of the emulsified layer was recorded. ES was calculated using the following formula:

ES (%) = [volume of emulsified layer (ml)/total volume of suspension (ml)] x 100

2.2.3.3 Foaming Capacity (FC)

To determine if the foaming capacity (FC) of the protein lupine will be affected by pH of the medium, protein suspensions (1%, w/v) were made with the pH adjusted to 4, 6 and 8 (addition of 0.1M NaOH or 0.1M HCl) [14]. Samples were individually beaten to foam in a domestic Sunbeam cake mixer at high speed for 5 min. The mix was immediately transferred to a 1000-ml graduated cylinder. The volume of the foam was recorded, and FC values were calculated, based on the following formula:

FC (%) = [foam volume (ml)/total volume of suspension (ml)] x 100

2.2.3.4 Foam Stability (FS)

Foam stability (FS) of the protein suspensions (1%, w/v) was recorded over a period of 120 min. The data were

recorded for foam volumes remaining at zero time, 30, 60, 90 and 120 min. The FS at each time interval was calculated as percentage of the initial foaming volume using the following formula:

FS (%) = [foam volume (ml) at a time interval/initial foam volume (ml)] x 100

2.2.4 Water and oil absorption capacity (WAC)

The water absorption capacity (WAC) was measured using the method of[15]. WAC is the volume of supernatant of the centrifuged (500xg for 30 min) solution (1 g in 10 ml distilled water), after it was allowed to stand at room temperature for 30 min. The oil absorption was determined by the method of [16]. It is the volume of supernatant of the centrifuged (500xg for 30 min) solution (1 g in 10 ml oil), after being allowed to stand at room temperature for 30 min.

2.2.5 Determination of protein digestibility(*in vitro*)

The *in vitro* protein digestibility of the samples was determined by enzymatic method[17]. A known weight of the sample containing 16 mg nitrogen was taken in triplicate and digested with 1 mg pepsin in 15 ml of 0.1 M HCl at 37 ºC for 2 h. The reaction was stopped by the addition of 15 ml 10% tri chloro acetic acid (TCA). The mixture was then filtered quantitatively through a what man No. 1 filter paper. The TCA-soluble fraction was assayed for nitrogen using the micro-kjeldahl method. Protein digestibility of the sample was calculated by the following formula:

Protein digestibility (%) = (N in supernatant – blank N / N in sample) x 100

2.2.6 Sensory evaluation

The sensory characteristics of the nuggets and cream caramel attributes were evaluated by a panel of Food Technology Research Institute (FTRI) staff members (15 judges) for color (10), palatability (10), texture (10), degree of maturity (10), taste (10), odor (10), and appearance (10), as suggested by[18].

2.2.7 Statistical analysis

Data analysis was performed using software [19]. All data were expressed as a mean of 3 replicates ± standard deviation. Analysis of variance was used to test for differences between the groups. Least Significant Difference (LSD) test was used to determine significant difference ranking among the mean values at $P< 0.05$.

3 RESULTS AND DISCUSSION

3.1 Chemical composition of sweet lupine powder, protein isolate and dickstriz

Data presented in Table 1 show that protein was significantly higher in sweet lupine protein isolate than in sweet lupine dickstriz and sweet lupine powder, in agreement with [20] and [21]. These publications reported that the protein concentrates (containing 60–70% of crude protein) and isolates (90% protein minimum on dry weight basis) obtained from lupine have a potential as an additional source of protein for human nutrition [22], with good functional and nutritional properties. Consequently, lupine protein isolate could be considered as the best source of nutritive value, due to its higher protein content. On the contrary, moisture, fat, fiber content and total carbohydrates were significantly lower in the sweet lupine protein isolate compared to the other samples.

Data presented in Table 2 show the major chemical constituents and caloric values of nuggets supplemented with 10, 25 and 50% lupine textured, and of control (0%). The highest significant protein, fiber and ash contents were noticed in nuggets prepared from 50% lupine textured, with regard to those found in nuggets prepared from chicken meat (control) and the tested nuggets (10 and 25%).

TABLE 1 -Chemical composition of sweet lupine powder, protein isolate and textured one (%) on dry weight basis.

Materials	Moisture	Ether extract	Protein	Fiber	Ash	TC*
Sweet lupine powder	12.38±0.06	2.70±0.10	34.50±0.77	3.43±.11	1.93±0.15	57.44±0.45
Sweet lupine protein isolate	0.39±0.33	1.03±.05	92.20±0.91	1.10±.10	1.08±0.52	3.67±0.56
Sweet lupine dickstriz	13.56±0.11	2.16±0.05	42.66±0.41	6.06±0.11	2.93±.20	46.19±0.75
LSD (0.05)	0.21	0.15	1.46	0,21	0.68	2.13

T.C* = Total carbohydrates calculated by difference; each value (average of 3 replicates) within the same column; each value (average of 3 replicates) is followed by the standard deviation

TABLE 2 -Chemical composition and caloric values of the manufactured nuggets calculated on dry weight basis.

Sample	Fat	Protein	Ash	Fiber	TC*	Caloric value
Nuggets (control)	32.88±0.34	22.06±0.40	1.50±0.30	2.23±.11	41.33±0.43	549.48
Nuggets with 10% SLD	32.0±2.0	22.36±0.49	2.0±0.00	3.23±.0.25	40.41±1.30	539.08
Nuggets with 25% SLD	28.0±2.0	22.40±0.34	3.16±0.32	4.46±0.41	41.98±2.30	509.52
Nuggets with 50% SLD	26.66±0.57	23.06±0.35	3.70±0.17	5.80±0.20	40.78±0.41	415.30
LSD (0.05)	2.73	0.76	0.44	0.54	2.55	2.13

TC = Total carbohydrates calculated by difference; each value (average of 3 replicates) within the same column; each value (average of 3 replicates) is followed by the standard deviation SLD= Sweet Lupine Dickstriz

TABLE 3 - Functional properties of sweet lupine (powder, protein isolate and dickstriz).

Functional properties	Sweet lupine powder	Lupine protein isolate	Sweet lupine dickstriz	LSD (0.05)
Water absorption(ml/g)	1.81±.20	2.845±0.20	2.54±.62	.89
Oil absorption (ml/g)	1.41±.70	1.56±.30	1.52±1.09	-
Emulsion capacity	80±2.40	82.2±1.82	81.1±1.65	1.07`
Emulsion stability	73.8±1.32	74.9±0.40	72.1±.60	.68
Foaming capacity	21.60±0.15	129.90±0.15	125.8±0.16	1.46
Foaming stability				
Zero time	96.09±0.10	97.30±0.10	90.4±0.20	0.09
20min	96.0±0.11	97.0±.10	90.10±.10	0.08
40 min	92.1±0.14	95.0±0.11	93.8±.10	0.01
60 min	90.1±0.05	94.5±0.15	93.±0.10	0.80
120 min	90.5±.10	93.8±.15	91.4±0.14	0.51

Table 2 also reveals that significant change in fiber and ash of all manufactured nuggets was noticed, and significant differences in caloric values were found among all the nugget blends. The highest amount was noticed in case of control. Overall, we concluded that addition of lupine dickstriz for each of the meat products led to a lower proportion of fat, an increase in fiber but a decrease in the percentage of caloric value. The lupine dickstriz can be used as a substitute for chopped meat, especially chicken, and this result is consistent with [23].

3.2 Functional properties of lupine powder, protein isolate and lupine dickstriz

The oil (OAC) and water (WAC) absorption capacity, highly desirable characteristics in the products, are of great importance from an industrial view point, since they reflect the emulsifying capacity [24]. Functional properties (WAC, OAC, EC, ES, FC and FS) of lupine powder protein isolate and lupine dickstriz are shown in Table 3. Protein isolates (PI) showed that the highest water absorption (WAC) and a higher level of oil absorption capacity (OAC) than lupine flour (2.85 ± 0.20 and 1.81± 0.20 versus 1.56± 0.61 and 1.42±0.30, respectively). Also a higher OAC value was reported for proteins of lupine compared with that found in case of lupine powder [25]. It was also observed a higher OAC for proteins of *Lupineu sangustifolius* than that of the lupine flour, probably due to the albumin and globulin amount fractions present in both tested materials [26]. Emulsifying capacities are important properties for application of lupine protein isolates in different food systems. Emulsion capacity and its stability of lupine powder, isolates and sweet lupine dickstriz showed significant differences. It simply means that a slightly significant variation was found between the corresponding samples. The lupine protein isolates showed a very high potential for the application as emulsifiers in different food products. On contrary, [26] observed that emulsion capacity property of flour and protein isolates were not significantly different. Proteins foam, a property when being whipped because of their surface-active properties. Protein isolates showed a higher FS value (93.8 %) after 120 min than that of the corresponding LF and LST (90.5 and 91.4%, respectively). From the pervious results, FC showed an increasing value as the protein content presence increased which was in agreement with [16]. The creation of foam capacity could be due to the fact that proteins in dispersion are lowering the surface tension at the water air interface [27].

3.3 *In vitro* protein digestibility

In vitro protein digestibility was improved in all samples under examination. Data in Table 4 show that the protein isolate was higher digestible than sweet lupine powder and lupine dickstriz . In addition, extrusion cooking resulted in an increased of protein digestibility, in comparison to raw lupine (Table 4). The increase in the protein digestibility is probably connected to the reduction in trypsin inhibitor activity (TIA), as protease inhibitors can reduce digestion by decreasing or inhibiting pancreatic action. Processing methods (soaking, cooking, dehulling) of lupine seeds improved protein digestibility [28]. From the obtained results (Table 4), it could be noticed that the protein digestibility percentage of nugget samples containing lupine dickstriz at levels of 10, 25 and 50 % was higher than that of control sample. The protein digestibility percentage increased with increasing level of lupine dickstriz incorporated into nuggets; these results are similar to those obtained by [27] who reported that the protein digestibility of lupine proteins is good *in vitro,* and compares favorably with soy protein. Also, from Table 4, it could be shown that the protein digestibility values of cream caramel samples increased with incorporated lupine protein isolate. These results are in accordance with those found by [29].

TABLE 4 - Protein digestibility of sweet lupine powder, dickstriz , lupine isolate nugget and cream caramel samples.

Sample	Protein digestibility (%)
Sweet lupine	
Powder	60.12
Dickstriz	70.25
Protein isolate	92.33
Nuggets	
Control	65.26
10% SLD	77.70
25% SLD	87.26
50% SLD	88.50
Cream caramel	
Control	86.14
25% SLPI	89.05
50% SLPI	91.60
75% SLPI	94.00
100% SLPI	96.50

SLD = Sweet Lupine dickstriz , SLPI = sweet lupine protein isolate

TABLE 5 –Organoleptic characteristics of the manufactured nuggets.

Sample	Color (10)	Odour (10)	Texture (10)	Palatability (10)	Taste (10)	Appearance (10)	Degree of maturity (10)
Control	8.05±0.79	8.73±0.76	8.53±0.90	8.40±1.10	8.60±0.96	8.10±0,84	8.75±0.85
Nuggets with 10% SLD	9.3±0.42	8.85 ±0.64	9.15±0.78	8.50±1.11	9.05±0.64	9.10±0.73	9.15±0.58
Nuggets with 25% SLD	9.25±0.47	8.86 ±0.41	9.33 ±0.57	8.63 ±0.61	8.55±0.73	9.24±0.59	9.35 ±0.45
Nuggets with 50% SLD	9.20±0.63	9.28±0.41	9.50±0.40	8.95±0.55	8.05±1.03	9.38±0.48	9.55±0.43
LSD (0.05)	0.54	o.52	0.62	0.04	0,22	0.61	0.55

Each value (average of 3 replicates) within the same column, each value is followed by the standard deviation.
SLD=Sweet Lupine Dickstriz

TABLE 6 –Organoleptic characteristics of the manufactured cream carmel samples.

Sample	Color (10)	Odor (10)	Texture (10)	Palatability (10)	Taste (10)	Appearance (10)
Control	8.80±0.91	9.10±0.84	8.70±1.27	8.40±1.10	9.00±1.08	8.45±2.48
Cream caramel with 25% SLPI	8.80±0.75	8.90 ±0.65	9.15±0.66	8.50±1.11	8.60±0.81	9.00±0.62
Cream caramel with 50% SLPI	8.65±0.70	8.85 ±0.78	8.55 ±0.59	8.63 ±0.61	8.40±2.02	8.35±0.85
Cream caramel with 75% SLPI	7.55±1.49	7.55±1.55	7.45±1.72	8.95±0.55	7.95±0.83	7.60±1.28
Cream caramel with100% SLPI	5.45±1.11	6.25±2.0	5.40±1.22	4.95±2.38	6.45±1.30	4.95±1.38
LSD (0.05)	0.93	1.15	1.05	1.02	1.16	1.35

Each value (average of 3 replicates) within the same column, each value is followed by the standard deviation; SLPI = sweet lupine protein isolate

3.4 Organoleptic characteristics evaluation

One of limiting factors for consumer acceptability are the organoleptic properties. Therefore, color, odor, texture, palatability, taste, appearance and degree of maturitywere determined (Table 5). Nuggets with 10, 25 and 50% possessed the best color, texture, degree of maturity, odor and appearance, with no significant difference in between, but significantly differed from control. With respect to the palatability of the tested nuggets, most consumers found them preferable, without significant differences. Meanwhile, there were significant differences between the other tested samples including control nuggets. In general, the tested nugget blends seemed to be more preferable than control, due to the highest degree in consumer acceptability, with respect to all organoleptic properties. These results agreed with that found by [30] who concluded that the incorporation of sweet lupine seed flour into beef burger patties, as a good meat replacer (functional and nutritional properties), at the tested levels (5 and 7.5% of meat weight used in burger Pattie formulation) resulted in producing burger patties without detrimental effects on the sensory attributes besides improving physiochemicalproperties and cooking measurements of the product. Data in Table 6 confirm that cream caramel with 25 and 50% SLPI and control possessed the best color, texture, palatability, odor and appearance with significant differences in between, but these cream caramel samples significantly differed from those with 75 and 100% lupine protein isolate.

Significant differences between the other tested samples including cream caramel (control, 25, 50, 75 and 100% lupine protein isolate) were observed. In general, the tested cream caramel blends (control, 25, 50 and75%) seemed to be more preferable than cream caramel with 100% lupine isolate because it showed the lowest degree of consumer acceptability with respect to all organoleptic properties.

4. CONCLUSION

Consequently, due to its nutritional composition and satisfactory functional properties, lupine dickstriz can be used in nuggets manufacturing. The addition of up to 10 % lupine dickstriz improves nutritive values. Based on these results, it can be concluded that use of lupine should be high as a substitute for chicken meat**.** It, also appears that 25 and 50 % protein isolate could be used for the partial substitution and as a successful alternative of eggs in egg-free cream caramel.

The authors have declared no conflict of interest.

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CORRESPONDING AUTHOR

Nasra A. Abd-Elhak
Food Technology Research Institute
Agricultural Research Center
Giza
EGYPT

E-mail: dr.nasraahmed@yahoo.com

NUTRITIONAL AND SENSORY EVALUATION OF SPONGE CAKE INCORPORATED WITH VARIOUS LEVELS OF JOJOBA MEAL AND PROTEIN ISOLATE

Hassan M. Sobhy[1], Ahmad M. Gaafar[2]and Akram M. El-Anany[2,*]

[1] Department of National Resources, Institute of African Research and Studies, Cairo University, Giza, Egypt
[2] Special Food and Nutrition Department, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt

ABSTRACT

Jojoba meal is a by-product remaining after the extraction of the oil from jojoba seeds. The aim of the current investigation was to evaluate the nutritional and sensory properties of sponge cakes incorporated with different levels of jojoba meal and protein isolate through determination of the chemical composition, functional properties of jojoba meal and protein isolate. Moreover, the nutrient composition and sensory characteristics of manufactured cakes were evaluated. Protein content of jojoba meal and protein isolate was 24.00% and 90.24%, respectively. The highest ($p < 0.05$) value of crude fiber was recorded for jojoba meal (17.00%) while protein isolate had significantly ($p < 0.05$) the lowest one (1.02%). Jojoba meal and its protein isolate contained 51.70 and 6.54% of carbohydrates, respectively. Potassium, phosphorus, magnesium and calcium constituted the major minerals of jojoba meal (1582.12, 713.53, 255.40 and 374.24 mg/100 g dry weight basis, respectively).Protein isolate of jojoba meal was found to possess relatively high values of water and fat absorption capacity as well as emulsification capacity. Sponge cakes incorporated with different levels of jojoba meal or its protein isolate had significantly ($p \leq 0.05$) higher protein content than that of the control sample (15.86 g/100 g cake). Fiber content of sponge cakes incorporated with 5, 10, 15 and 20% of jojoba meal were about 1.82, 2.24, 2.98 and 3.85 times as high as that in control sample. No significant ($p \geq 0.05$) differences in specific volume were observed between control sample and cakes supplemented with 5, 10 and 15% of protein isolate as well as 5% of jojoba meal. However, partial substitution of wheat flour with 10, 15 and 20 % of jojoba meal as well as 20% of jojoba protein isolate caused significant ($p \leq 0.05$) reduction in the specific volume of formulated cakes. The sensory evaluation results suggest that substitution of wheat flour with 5 and 10% of jojoba meal flour can yield cake samples with acceptable sensory properties; however, its protein isolate flour could be incorporated until 20 %, without adversely affecting the acceptability.

KEYWORDS: Jojoba *(Simmondsiachinensis)*, protein isolate, function properties, sponge cake, sensory evaluation

1. INTRODUCTION

Jojoba *(Simmondsiachinensis*[Link] Schneider), an evergreen shrub, native to the arid zones of the United States and northern Mexico, produces a seed that contains a liquid wax (jojoba oil) useful in cosmetics, pharmaceutical products, and industrial lubricants [1, 2]. The seed flour, remaining after winning the oil, is composed of about 30% protein, dietary fiber and carbohydrates, and could possibly serve as an animal feed supplement. Protein-rich residue remains after oil extraction of jojoba seeds known as defatted jojoba meal. This meal contains 20–32% of protein, consisting mainly of 79% albumins and 21 % globulins [3].

The defatted meal also contains sugars and 11-15% of a unique group of natural products, all structurally related to simmondsin. Simmondsin is an effective agent in satisfying hunger, and used for obtaining an ideal growth rate in chicken [4]. The factor that hinders the use of jojoba meal for human food is the presence of simmondsin and its derivatives [5, 6].

Different authors have described methods for the inactivation or elimination of simmondsin from jojoba meal. Water was found to extract all the simmondsin, but repeated extractions with methanol or 90% ethanol were not efficient in completely removing the substance. Acetone, isopropanol, water, methanol and 85:15 dichloromethane:methanol have been already used to extract the simmondsin from the defatted meal [7] but only water and methanol extracted simmondsin almost completely. Water has been shown to extract simmondsin and its analogues from jojoba meal, but only chloroform, methanol, acetonitrile:water and acetone extracts were suitable for chromatographic separations [8]. In this respect, [9] reported that nearly all the simmondsin and oil could be easily removed from ground jojoba seeds in one step by repeated extraction with water at 90 °C. These authors [9] also found that the optimum extraction time and temperature were 1.5 h and 90 °C, respectively.

The chemical composition of jojoba meal protein isolate was studied by [10], who found that this isolate is composed of about 92.35% protein, 1.2% crude oil, 0.76% crude fibre, 1.13% ash, and 5.56% carbohydrates, on a dry weight basis.

Bakery products are consumed all over the world. Cakes are important bakery products. Their worldwide market currently grows with about 1.5% per year. Challenges in the cake market include cost reduction, increased shelf-life and quality control. Cake making consists of mixing the ingredients into a batter which, because of the high level of liquid phase in cake recipes, has a low viscosity, and baking such a batter into a cake [11]. Wheat flours used in cake elaboration have lower protein content, and it is known that one of the most important characteristics of cake elaboration flours is particle size [12]. Gluten does not play an important role in this kind of product, which means that flours from other cereals [13-15], or even from pulses, such as chickpeas or lupine [16, 17], can be used.

There is no published information on the nutritional and organoleptic evaluation of products containing jojoba meal and its protein isolate; therefore, the aim of the current study was to evaluate the nutritional and sensory evaluation properties of sponge cakes supplemented with different levels of jojoba meal and protein isolate through determination of the chemical composition, functional properties of jojoba meal and protein isolate. Moreover, the nutrient composition and sensory properties of the manufactured cakes were evaluated.

2. MATERIALS AND METHODS

Jojoba (*Simmondsiacalifornica*) meal was obtained from Egyptian Natural Oil Co 10th of Ramdan City, small Industrial Complex, Zone C2 Building #2, Egypt. Wheat flour (72% extraction) was obtained from Five-Stars Milling Company, Suez, Egypt. Fresh eggs, whole milk powder, baking powder, vanilla, salt, sugar and butter were purchased from a local market in Giza, Egypt. All reagents and chemicals that were used in this work were of analytical grade.

2.1 Preparation of autoclaved meal (treated jojoba meal)

An appropriate amount of jojoba meal was dry-autoclaved at 121 °C (15 lb/in^2 pressure) for 15 min to inactivate the activity of simmondsin compounds. The treated samples were dried in an electric air draught oven ((IsotempOven, Fisher Scientific, Montreal, Quebec) at 50 °C for 24 h. The dried samples were ground in an electric grinder (Braun, Model 1021, Germany), passed through a 150-µm mesh sieve, and stored in glass containers at 4 °C for further analysis.

2.2 Preparation of jojoba meal protein isolates

Jojoba meal protein isolates were prepared by isoelectric point precipitation technique [18, 19]. These isolates were dried under vacuum at 50 °C for 24 h.

2.3. Analytical methods

2.3.1. Moisture, protein, fat, crude fiber and ash of raw materials and the produced cakes

The moisture, protein, fat, crude fiber and ash of raw materials and the produced cakes were determined using the standard methods described by AOAC International [20]. Total carbohydrate was then calculated as the difference between 100 and the sum of the percentages of moisture, crude protein, total fat, and ash [21]. The sample calorific value was calculated from the percentage of crude protein, total carbohydrates and total fat. The conversion factors used were 4.0 kcal/g for protein and carbohydrates, and 9.0 kcal/g for total fat [22].

Minerals were determined in a diluted solution of the ashed samples according to the method outlined in [20], by using flame atomic absorption spectroscopy (Perkin Elmer, model A-3300).

2.3.2. Water absorption, fat absorption and emulsification capacity determinations

2.3.2.1. Water absorption

It was measured according to the procedure of [23]. Flour (2 g) of the flour sample was put into a weighed centrifuge tube, 15 ml of distilled water was added, and the material suspended in water using a Vortex mixer for 1 min. After holding a period of 30 min, the tube was centrifuged for 30 min at 3000xg. The supernatant liquid was discarded and the tube kept mouth-down at an angle of 15 to 20° in an electric-forced draught air oven at 50 °C. It was allowed to drain and dry for 25 min. Then, it was kept in a desiccator at 25 ± 2 °C, and subsequently weighed. Water absorption is expressed as the amount of water retained by 100 g of flour or protein.

2.3.2.2. Fat absorption

The method of [24] was followed. It was performed as water absorption capacity using 10 ml of refined corn oil instead of distilled water. The results are expressed as ml of oil absorbed by 100 g of flour or protein.

2.3.2.3. Emulsification capacity

Emulsification capacity (ml oil/g protein at pH 9) was determined as described by [25]. The emulsification capacity (EC) was conducted at room temperature using 2 g flour sample and 23 ml distilled water, and blending for 30 sec in a Braun blender at low speed, for suspending the material. After complete dispersion, refined corn oil was added continuously from a burette (rate of 0.45 ml oil/sec), and blending continued until the emulsion break point was reached (phase separation into two layers). Emulsification capacity is expressed as ml of oil emulsified by 1 g of flour or protein.

2.3.3. Specific volume measurement

Specific volume was obtained from the divided volume with weight [26].

2.4. Sensory evaluation

Sensory evaluation of cakes was performed by 10 trained panellists from the staff of Food Technology Research Institute, Agriculture Research Center, Giza, Egypt. Samples were presented in paper plates coded with 3-digit random

numbers. Cakes were evaluated for crumb appearance, taste, texture, flavour and aroma. A hedonic scale of 1 to 10 was used (1 = poor and 10= excellent). Water was provided, so that panellists could cleanse their palates between samples.

2.5 Statistical analysis

Data were statistically analyzed in completely randomized design in factorial arrangement according to the procedures outlined by [27], and the treatment means were compared by least significant differences (LSD) and Duncan`s multiple range tests using SPSS program package.

3. RESULTS AND DISCUSSION

3.1. Chemical composition of jojoba meal and protein isolate (dry weight basis)

Chemical compositions of jojoba meal and protein isolate are presented in Table 1. Moisture contents of jojoba meal and protein isolate were 7.17 and 4.30%, respectively. These low moisture contents of jojoba meal and protein isolate could be partly responsible for the non-deterioration of these products over a long period. The monitoring of moisture content in foods or food products is crucial because high moisture content can reduce the shelf-life span of the food products by increasing microbial degradation activity, resulting in bad odour and unacceptable taste of the product [28]. As shown in Table 1, the protein content of protein isolate was approximately 3.76-fold higher than that of jojoba meal. The protein content of jojoba meal and protein isolate was 24.00 and 90.24%, respectively. This finding may focus the interest of utilizing jojoba meal and its protein isolate as a high protein source in some food formulations. Low levels of fat content were recorded for jojoba meal and protein isolate (1.90 and 0.40 %). The highest ($p < 0.05$) value of crude fiber was recorded for jojoba meal (17%) while protein isolate had significantly ($p < 0.05$) the lowest one (1.02%). Defatting process of jojoba seeds led to the increase of the crude fiber content in jojoba meal. Therefore; jojoba meal could be considered as a good source of dietary fiber. This is an interesting finding, since the consumption of dietary fiber has been related to prevention of cardiovascular disease, diabetes, and digestive tract diseases, considering that it lowers the glycemic index of food as well as serum cholesterol levels [29]. The carbohydrate content of jojoba meal was approximately 7.90-fold higher than that of protein isolate. Jojoba meal and its protein isolate contained 51.70 and 6.54%, respectively. The higher level of carbohydrate in jojoba meal could be due to the removal of oil and lipids during defatting process. The proximate composition of jojoba meal was similar to that reported by [10, 30-32].

Mineral contents of jojoba meal and protein isolate (mg/100 g dry weight basis) are presented in Table 2. Jojoba meal is considered as a good source of potassium, phosphorus, magnesium and calcium constituting the major minerals of jojoba meal (1582.12, 713.53, 255.40 and 374.24 mg/100 g dry weight basis). Sodium, iron, copper and zinc were found in low quantities in jojoba meal. Leguminous plants are a good source of minerals and are higher in Ca than most cereals [33]. Therefore, jojoba meal could be used as supplementation for cereal flour to improve its mineral content. Mineral contents of jojoba meal were higher than that of the protein isolate (Table 2). These values differ from earlier findings [10] who reported 350 and 1312.60 mg/100 g for phosphorus and potassium, respectively, in the jojoba meal; 486.72, 132.65 and 26.13 mg/100 g were found for potassium , phosphorus and calcium, respectively, in the protein isolate. These differences may be due to variation in the soil and climatic conditions.

TABLE 1 - Chemical composition (%) of jojoba meal and protein isolate (g/100 g dry weight basis).

Component (%)	Jojoba meal	Proteinisolate	LSD (0.5)
Moisture	7.17^{a}±0.35	4.30^{b}±0.1	0.583
Protein	24.00^{b}±1.19	90.24^{a}±1.16	2.663
Oil	1.90^{a}±0.4	0.40^{b}±0.01	0.641
Crude fiber	17.00^{a}±2.03	1.02^{b}±0.02	3.254
Ash	5.40^{a}±0.01	1.80^{b}±0.1	0.161
Carbohydrates*	51.70^{a}±3.63	6.54^{b}±1.29	6.175

Data are expressed as means ± standard deviation (SD); values given represent means of 3 determinations; values followed by the same letter are not significantly different ($p \leq 0.05$); * = by difference.

TABLE 2 - Mineral contents (mg.100 g^{-1}) of jojoba meal and jojoba protein isolate.

Element (mg.100 g^{-1})	Jojoba meal	Protein isolate	LSD (0.5)
Ca	374.24^{a} ±1.4	24.80^{b} ±1.53	3.324
Na	31.01^{a} ±1.04	12.91^{b} ±0.85	2.153
Mg	255.40^{a} ±1.25	92.01^{b} ±1.76	3.460
Mn	4.02^{a} ±0.87	1.60^{b} ±0.12	1.407
Cu	1.82^{a} ±0.45	0.72^{b} ±0.06	0.727
Fe	8.45^{a} ±1.04	3.85^{b} ±0.42	1.797
K	1582.12^{a} ±22.7	382.61^{b}±11.3	40.64
P	713.53^{a} ±13.25	143.01^{b}±5.2	21.55
Zn	2.51^{a} ±0.82	0.72^{b} ±0.19	1.349

Data are expressed as means ± standard deviation (SD); values given represent means of 3 determinations; values followed by the same letter are not significantly different ($p \leq 0.05$).

3.2. Functional properties of jojoba meal and its protein isolate

3.2.1. Water absorption capacity (WAC)

The interactions of protein with water are important in relation to dispersibility, water absorption and binding, swelling, viscosity, gelation and surfactant properties, as these properties influence the important functions of proteins in meat, bakery and beverage systems [34]. WAC refers to the ability of the protein to imbibe water and retain against gravitational force. Intrinsic factors affecting the WHC of food protein include amino acid composition, protein conformation and surface hydrophobicity [35]. The water absorption capacity (WAC) of jojoba meal and protein isolate is shown in Table 3. As it can be seen, protein isolate had a higher WAC than jojoba meal. This is likely due to the fact that the protein isolate has a great ability to swell, dissociate and unfold exposing additional binding sites, whereas the carbohydrates and other non-protein components may impair it [33, 36]. The WAC values for jojoba meal and protein isolate were 153.9 and 330.08 g H_2O/100 g flour, respectively. This result indicates that jojoba meal and protein isolate had good water binding capacity, possibly due to the interaction between polar amino acid residues of protein and molecules of water. The results of water absorption capacity showed an advantage for jojoba meal and its protein isolate utilization in some bakery products, or use as meat extenders, which require holding of more water.

3.2.2. Fat absorption capacity (FAC)

Oil binding capacity is another important functional property of proteins in food systems. It is a critical property of flavour retention [37]. The ability of proteins to bind fat is an important phenomenon, since fats act as flavour retainer and increase the mouth-feel of food [38]. Significant ($P < 0.05$) differences were observed between jojoba meal and its protein isolate in their fat absorption capacities (Table 3). Protein isolate of jojoba was higher in absorbing oil than jojoba meal. FAC is attributed to the physical entrapment of oil and to the number of non-polar side chains on proteins that bind hydrocarbon chains on the fatty acids [39]. This is in agreement with [40-42] who reported that FAC increased with increasing protein content in cashew nut, soya and kenaf protein products, respectively. The fat absorption capacity values of jojoba meal and protein isolate were 194.73 and 344.39 g oil/100 g flour, respectively. The FAC value obtained for jojoba protein isolate is similar to that obtained by [33] for bitter lupin protein isolate (3.73 ml oil/g) while this OAC value was lower to that of cashew nut (4.42 ml oil/g), as reported by [41], and lower than 3.50 ml oil/g, which was reported for garden cress seed protein isolate [43]. The difference between FAC values of different samples could be related to the variation in amino acid compositions and several parameters, such as hydrophobicity, degree of denaturation, and the size and flexibility of the protein [44]. FAC is useful in formulation of foods, such as sausages and bakery products [45], and this shows that jojoba meal and its protein isolate would be useful in this respect.

3.2.3. Emulsification capacity

The formation and stability of emulsion is very important in food systems, such as salad dressings. Proteins are composed of charged amino acids, non-charged polar amino acids and non-polar amino acids, which make protein a possible emulsifier, the surfactant possessing both hydrophilic and hydrophobic properties, and able to interact with both water and oil in food systems [46]. The emulsifying capacity of jojoba meal and protein isolate is presented in Table 3. The emulsifying capacity values for jojoba meal and protein isolate were 98.00 and 145.5 ml oil/g flour, respectively. The emulsification properties of protein-containing products like legume flours may result from both soluble and insoluble protein, as well as other components, such as polysaccharides. Protein can emulsify and stabilize the emulsion by decreasing surface tension of the oil droplet and providing electrostatic repulsion on the surface of the oil droplet [47].

TABLE 3 -Waterandfatabsorption of jojoba meal and protein isolate.

Samples	Water absorption	Fat absorption
jojoba meal	153.91^{b}±1.51	194.73^{b}±0.98
protein isolate	330.08^{a}±1.55	344.39^{a}±2.72
LSD 0.5	3.475	4.642

Data are expressed as means ± standard deviation (SD); values given represent means of 3 determinations; values followed by the same letter are not significantly different ($p \leq 0.05$).

3.3. Nutrient composition of sponge cakes incorporated with various levels of jojoba meal and protein isolate

The nutritional composition of sponge cakes incorporated with various levels of jojoba meal and protein isolate are presented in Table 4. The first part of these results shows the nutritional composition of sponge cakes incorporated with various levels of jojoba meal (Table 4). Themoisture contents of sponge cakes were significantly different. Generally, sponge cakes incorporated with different levels of jojoba meal had significantly ($p \leq 0.05$) higher moisture content than that of control. Moisture content of sponge cakes incorporated with various levels (5, 10, 15 and 20%) of jojoba meal ranged from 26.46 to 28.50%. The highest levels of moisture content were recorded for sponge cakes incorporated with 15 and 20% of jojoba meal (27.12 and 28.50 %, respectively). As jojoba meal level increased, moisture contents significantly ($p \leq 0.05$) increased. Thus, the higher moisture content of jojoba meal-incorporated cakes might be due to the water-binding properties of jojoba meal, which seems to positively affect the moisture retention of the formulated cakes; this was expected because of the high fiber, carbohydrate and protein contents of jojoba meal flour.Sponge cakes incorporated with different levels of jojoba meal had significantly ($p \leq 0.05$) higher protein content than that of control (15.86 g/100 g cake). Protein content significantly ($p < 0.05$) increased with the incorporation of different levels of jojoba meal (Table 4). Protein content in the cakes varied from 15.86 to 18.77%. The highest levels of protein were recorded for sponge cakes incorporated with 15 and 20% of jo-

joba meal (17.87and 18.77%, respectively). This observation could be attributed to the fact that blending of two or more plant-based food materials increases the nutrient density of the product[48]. No significant (P≤0:05) differences in fat content were observed between control and those cakes incorporated with various levels of jojoba meal. The fibers content significantly ($p<0.05$) increased with the incorporation of various levels of jojoba meal (Table 4). Fiber content of sponge cakes incorporated with 5, 10, 15 and 20% of jojoba meal were about 1.82, 2.24, 2.98 and 3.85 times as high as that in control sample. Therefore, jojoba meal could be considered as a good source of dietary fiber. This is an interesting finding since the consumption of dietary fiber has been related to prevention of cardiovascular disease, diabetes, and digestive tract diseases, considering that it lowers the glycemic index of food as well as serum cholesterol levels [29]. The ash content of food material could be used as an index of mineral constituents of the food because ash is the inorganic residue, remaining after water and organic matter have been removed by heating in the presence of an oxidizing agent [49]. The results revealed also that the ash content increased from 1.63 % in control sample to 1.79, 2.12, 2.23 and 2.54% in cakes supplemented with 5, 10, 15 and 20% of jojoba meal, respectively. However, statistical analysis showed that there were no significant differences between control and those cakes above. The carbohydrate content decreased significantly from 69.81 g per 100 g in control samples to 67.98, 66.63, 64.78 and 62.54 in those samples incorporated with 5, 10, 15 and 20% of jojoba meal, respectively. This decrease was gradually, and significantly increased with increasing incorporation level. These findings may be due to the fact that jojoba meal is higher in protein, fiber and ash but lower in carbohydrate as compared to wheat flour. [10] reported that protein represents the most abundant nutrient in jojoba meal; it contained 22.9% protein, 1.2% crude oil, 15.4% crude fiber, 4.1% ash and 56.4% nitrogen-free extract, on dry weight basis.

The second part of Table 4 shows the effect on the nutritive values of the formulated cakes when adding different levels of jojoba protein isolate. As expected, the supplementation with different levels of protein isolate significantly ($p<0.05$) increased the levels of protein content in the formulated cakes. Protein content of sponge cakes supplemented with 5, 10, 15 and 20% of jojoba protein isolate were about 1.17, 1.36, 1.47 and 1.61 times as high as that in control sample. These increases were gradually, and significantly increased with increasing replacing rates. These increases could be attributed to the fact that protein isolate contains 90.24 % protein on dry weight basis. However, control and sponge cakes supplemented with 5, 10, 15 and 20% of jojoba protein isolate did not vary significantly ($p>0.05$) in their fat, fiber and ash contents. Replacing wheat flour with different levels of jojoba protein isolate reduced the carbohydrate content of the formulated cakes by 3.81 to 13.72%. This decrease was gradually, and significantly increased with increasing replacing level, due to the high protein content and low carbohydrate of jojoba protein isolate.

The specific volume of baked cakes indicates the amount of air that can remain in the final product. A higher gas retention and higher expansion of cakes leads to a higher specific volume [50]. The specific volume of sponge cakes incorporated with various levels of jojoba meal and protein isolate are presented in Table 5. No significant ($p\geq0.05$) differences in specific volume were observed between control sample and cakes supplemented with 5, 10 and 15% of protein isolate as well as 5% of jojoba meal. However, partial substitution of wheat flour with 10, 15 and 20% of jojoba meal as well as 20% of jojoba protein isolate caused significant ($p\leq0.05$) reduction in specific volume of formulated cakes. This could be explained by the fact that substitution of wheat flour with jojoba meal causes gluten dilution and, consequently, affects

TABLE 5 - Specific volume (cm^3/g) of sponge cakes incorporated with various levels of jojoba meal and protein isolate.

Samples		
Incorporation level (%)		
	Jojoba meal	Protein isolate
0 (control)	$2.075^{a}\pm0.10$	$2.075^{a}\pm0.10$
5	$2.003^{a}\pm0.13$	$2.08^{a}\pm0.11$
10	$1.96^{ab}\pm0.09$	$2.04^{a}\pm0.20$
15	$1.93^{ab}\pm0.18$	$2.00^{a}\pm0.13$
20	$1.87^{b}\pm0.15$	$1.94^{ab}\pm0.21$
LSD at 0.05 = 0.094		

Data are expressed as means ± standard deviation (SD); values given represent means of 3 determinations; values followed by the same letter are not significantly different ($p\leq0.05$).

TABLE 4 - Nutrient composition of sponge cake incorporated with various levels of jojoba meal and protein isolate.

Nutrient	Control	Jojoba meal level (%)				Jojoba proteinisolate (%)				LSD
		5	10	15	20	5	10	15	20	
Moisture (%)	$25.25^{b}\pm1.14$	$26.46^{ab}\pm1.23$	$26.98^{ab}\pm1.29$	$27.12^{ab}\pm1.32$	$28.50^{ab}\pm1.27$	$28.23^{ab}\pm1.36$	$28.63^{ab}\pm1.33$	$29.71^{a}\pm1.37$	$29.93^{a}\pm1.39$	2.23
Crude protein (%)	$15.86^{c}\pm2.07$	$16.56^{c}\pm2.12$	$17.01^{c}\pm2.41$	$17.87^{bc}\pm1.98$	$18.77^{bc}\pm2.03$	$18.56^{bc}\pm2.09$	$21.59^{abc}\pm2.50$	$23.45^{ab}\pm2.60$	$25.61^{a}\pm2.90$	3.97
Ether extract (%)	$11.53^{a}\pm1.76$	$11.55^{a}\pm1.70$	$11.60^{a}\pm1.68$	$11.67^{a}\pm1.64$	$11.67^{a}\pm1.67$	$11.47^{a}\pm1.81$	$11.41^{a}\pm1.59$	$11.36^{a}\pm1.51$	$11.30^{a}\pm1.48$	2.83
Crude fiber (%)	$1.17^{d}\pm0.34$	$2.13^{cd}\pm0.54$	$2.63^{c}\pm0.51$	$3.49^{b}\pm0.62$	$4.51^{a}\pm0.59$	$1.13^{d}\pm0.39$	$1.12^{d}\pm0.37$	$1.10^{d}\pm0.36$	$1.03^{d}\pm0.27$	0.78
Ash (%)	$1.63^{a}\pm0.41$	$1.79^{a}\pm0.49$	$2.12^{a}\pm0.39$	$2.23^{a}\pm0.44$	$2.54^{a}\pm0.45$	$1.69^{a}\pm0.40$	$1.74^{a}\pm0.41$	$1.79^{a}\pm0.42$	$1.83^{a}\pm0.44$	0.73
Total carbohydrate*(%)	$69.81^{a}\pm4.58$	$67.98^{a}\pm4.84$	$66.63^{a}\pm4.98$	$64.78^{a}\pm4.64$	$62.54^{a}\pm4.71$	$67.15^{a}\pm4.69$	$64.14^{a}\pm4.87$	$62.28^{a}\pm4.91$	$60.23^{a}\pm5.09$	8.25
Calories (kcal)	$446.45^{a}\pm6.89$	$442.11^{a}\pm7.22$	$439.05^{a}\pm6.71$	$435.27^{a}\pm6.79$	$430.18^{a}\pm6.21$	$446.07^{a}\pm6.72$	$445.53^{a}\pm6.76$	$445.16^{a}\pm6.79$	$445.06^{a}\pm6.64$	11.58

Data are expressed as means ± standard deviation (SD); values given represent means of 3 determinations; values followed by the same letter are not significantly different ($p\leq0.05$). LSD: least different significantly at $p \leq 0.05$ according to Duncan's multiple range test; * = by difference.

TABLE 6 - Sensory evaluation of cakes incorporated with various levels of jojoba meal and its protein isolate.

Component (%)	Crumb appearance		Taste		Texture		Flavour		Colour	
	jojoba meal	protein isolate	jojoba meal	protein isolate	jojoba meal	protein isolate	jojoba meal	protein isolate	jojoba meal	protein isolate
0%	9.11a ± 0.50	9.00a ± 0.5	9.14a ± 0.39	9.38a ± 0.32	9.12a ± 0.32	8.86a ±0.50	9.24a ± 0.41	9.27a±0.34	9.16a±0.45	9.18a±0.40
5%	9.08a ± 0.33	9.24a ± .026	9.10a ± 0.59	9.36a ± 0.26	9.09a ± 0.51	9.00a± 0.50	9.00a ± 0.49	9.13a±0.45	9.12a±0.60	8.90a±0.49
10%	9. 03a ± 0.51	8.91a ± 0.76	9.07a ± 0.56	9.35a ± 0.32	9.05a ± 0.66	8.90a ± 0.62	9.00a ± .059	8.90a±0.30	9.09a±0.63	8.86a±0.80
15%	8.77b ± 0.87	8.84a ± 0.90	8.23ab ± 1.23	9.30a ± 0.59	8.31b± 0.80	8.86a± 0.50	8.63a± 0.84	8.86a±0.67	8.67b±0.87	8.72a±0.68
20%	8.17bc ± 0.83	8.64a ± 0.81	7.92b ± 1.10	9.27a ± 1.63	8.30b± 0.90	8.81a± 0.56	8.54a ± 0.76	8.77a±0.68	8.14bc±0.87	8.72a±0.56
LSD .05	0.55	0.59	0.72	0.42	0.57	0.64	0.55	0.44	0.60	0.52

Data are expressed as means ± standard deviation (SD); means in the same column with different letters are significantly different ($p \leq 0.05$)

the optimal gluten matrix formation during the mixing, fermentation and baking steps.Cakes incorporated with 20% of jojoba meal had significantly the lowest specific volume (1.87 cm^3/g). These findings may be attributed to the increase of water absorption and high water retention capacity, resulting in the increase of weight and decrease of cake volume [51, 52].

3.4 Sensory evaluation

The sensory properties of sponge cakes incorporated with various levels of jojoba meal and protein isolate are presented in Table 6. No significant ($P \geq 0.05$) differences were observed in crumb appearance, taste, texture , flavour and colour among control cake and cakes containing 5 and 10% of jojoba meal, as well as 5, 10, 15 and 20% of jojoba protein isolate. However, the cakes containing 15 and 20% of jojoba meal had significantly lower values. These decreases were gradually, and significantly increased with increasing substitution level of jojoba meal. These results are in good agreement with those reported by [53] who found that organoleptic properties (colour, flavour and overall acceptability) were improved with a low proportion of chickpea flour, especially for 5% w/w substitution. Generally, cakes, prepared from wheat flour and substituted with 5, 10, 15 and 20% of jojoba protein isolate were similar with control sample (100 % wheat flour) while increasing the substitution of jojoba meal to 15 and 20% had negative effects on the sensory properties of the formulated cakes. This observation suggests that substitution of wheat flour with 5 and 10% of jojoba meal flour can yield cake samples with acceptable sensory properties; however, its protein isolate flour could be incorporated upto 20 % without adversely affecting the acceptability.

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CORRESPONDING AUTHOR

Akram M. El-Anany
Special Food and Nutrition Department
Food Technology Research Institute
Agricultural Research Center
Giza
EGYPT

E-mail: E-mail: akram_anany@yahoo.com

NOVEL FORMULATIONS FOR MANUFACTURING MOZZARELLA CHEESE ANALOGUES WITH HIGH QUALITY

Mahmoud A. Mailam[1,*], Rezk A. Awad[2], Mostafa A. Zedan[1] and Abdel-Moneim E. Hagrass[2]

[1] Food Technology Research Institute, Agriculture Research Center, El-Giza, Egypt
[2] Food Sci. Dept., Faculty of Agric., Ain Shams Uni. Shoubra Khima, Cairo, Egypt

ABSTRACT

Mozzarella cheese analogue (MCA) is a formulated cheese substitute which has the potential to overcome problems associated with natural cheeses, such as high production and storage costs, functional variability and nutritional inflexibility. Analogue Mozzarella cheese was manufactured from novel formulations of rennet casein substituted by cheese curd, "tailor-made" to suit manufacturing process. Resultant analogue cheeses were analyzed for their chemical properties. Functional characteristics (meltability, free oil and oil separation index), texture profile analysis and sensory quality attributes, total protein, fat, ash, salt and microstructure were also estimated. All obtained results of analogue treatments were compared to control (without cheese curd). The results indicated that substitution of rennet casein-based formulation of cheese analogue by curd led to lower moisture and acidity whereas lactose, pH value and soluble nitrogen were increased, compared to control. Meltability and oil separation index of cheese analogue were significantly affected by rennet casein substitution. Adding cheese curd in formulation of analogue cheese improved the functional characteristics. MCA showed higher firmness, cohesiveness, gumminess, and chewiness, with low adhesiveness and resilience by adding cheese curd in the formulations. All treatments were sensorically acceptable showing higher significant quality attributes in treatments with replacing of cheese curd in base formulation than control, and treatment T2 showed the best results. During storage of Mozzarella analogue, a significant increase in SN/TN, acidity, meltability, oil separation index and adhesiveness was observed while moisture, lactose, and firmness, cohesiveness, gumminess, chewiness and resilience were decreased.

KEYWORDS: Mozzarella cheese analogue (MCA), rennet casein, curd, functional properties texture, and sensory quality

1. INTRODUCTION

Production of Mozzarella has been grown considerably in recent years with the spread of fast foods, especially pizza stores. The annual production of Mozzarella cheese increased in USA from about 2.633.737 thousand lbs in 2000 to 3.718.685 thousand lbs in 2013 [1]. Mozzarella is an irreplaceable cheese for pizza because of its stretchability, and it has a number of precise functional requirements. There has been a sharp increase in the consumption of pizza worldwide, resulting in high demand for Mozzarella or Pizza cheese. Mozzarella cheese, classified as semi-hard cheese, is regularly produced with lower yield percentages, especially with cow milk [2]. Due to its expensive cost, analogue Mozzarella cheese may offer an excellent opportunity to substitute the traditional product, and offers the same or better nutritional and textural characteristics [3, 4]. Cheese analogues are cheese-like products manufactured by blending various edible oils/fats, proteins, other ingredients and water into a smooth homogeneous blend with the aid of heat, mechanical shear and emulsifying salts [5, 6]. MCA/cheese substitutes or imitation cheese may be generally defined as the products partly or wholly substituting or imitating cheese, and in which milk fat, milk protein or both are partially or wholly replaced by non-milk based alternatives, principally of vegetable origin [7]. Kiely *et al.* [8] reported that casein-based analogue pizza cheese showed a more stable functionality than natural low moisture Mozzarella cheese (LMMC) during storage at 4 ºC for 28 days, with respect to apparent viscosity and free oil. Such stability makes analogues very attractive to the food processing and service industries. MCA, with relation to natural cheeses, has several advantages including the lower cost owing to the use of vegetable oils instead of milk fat, lower manufacturing costs, relatively easy formulation with customized textural and functional attributes, and the relatively high stability of textural and cooking properties during storage at refrigerated temperature. The major protein source in dairy-based Analogue Cheese Products (ACPs) is caseinate or rennet casein. Rennet casein is favored for semi-hard block products where it generally imparts better stringiness and stretchability than acid casein or Na- or Ca-caseinates [7].

Therefore, the objective of this research is to study the effect of replacing rennet casein in different novel formulations of MCAs with fresh cheese curd on the functionality of the resultant products.

2. MATERIALS AND METHODS

2.1 Materials

Cheese curd was manufactured of fresh cow milk standardized to 3% fat and pasteurized at 72 ºC/15 sec. Acetic acid was added (2.5 ml/100 kg) to pasteurized milk at 10 ºC with agitation to be properly well mixed; then, the temperature of milk was increased to 38±2 ºC. Thereafter, the coagulation of cheese milk was completed by adding rennet as coagulant to complete the process within 40-60 min. The curd was cut into cubes using American Knives, and then, the cut curds were left in the warm whey for about 50–60 min with periodic gentle agitation. The whey was drained when pH reached 5.80-5.90 and the curds gently packed together, and were kept in the warm cheese vat (38 ±2 ºC) till the curd pH reached 5.6-5.8. Then, the manufacture processing progress of cheese curd, tailor-made to be blended in formulation of MCA, was stopped. The cheese curd was analyzed before being used in blend formulations and the composition is shown in Table 1. Rennet casein produced by Herbignac Cheese Ingredients, Rue Guérande, Herbignac, France was used, and its composition is also shown in Table 1. Sodium chloride, emulsifying salt (E 331), potassium sorbate and lactic acid were obtained from El-Nasr Co., Alexandria, Egypt. Vegetable fat (palm oil) was obtained from MIGOP Company, Suez, Egypt. Whey protein concentrated powder was obtained from Alpha trade Co., Alexandria, Egypt. Butter flavor was obtained from Redachem Egypt. LIC. Maadi, Cairo, Egypt. Modified potato starch and stabilizer (mono gel 90) were obtained from Mashreq for Business Development Co., Alexandria, Egypt.

TABLE 1 - Chemical composition and pH of cheese curd and rennet casein used in manufacture of Mozzarella cheese analogue (MCA).

Composition (%)	Cheese curd	Rennet casein (RC)
Moisture	49.27	5.59
Total protein	21.93	85.25
Fat	24.5	0.50
Lactose	2.5	0.18
Ash	1.60	8.47
pH value*	5.70	7.0

* pH value of RC was determined in 10% solution (w/v).

2.2 Mozzarella cheese analogue manufacture

MCA was manufactured as reported by O'Malley *et al.* [9]. Three different blends containing cheese curd and control 1 of only rennet casein were formulated. The composition of all MCA treatments is presented in Table 2. The resultant MCA was analysed when fresh, and also after 2 and 4 weeks of storage at the refrigerator (5 ±2 °C).

2.3 Cheese analysis

Mozzarella analogue samples were examined for moisture, salt, fat contents and soluble nitrogen (SN) contents as described by Ling [10]. Ash, titratable acidity and total nitrogen (TN) were analyzed as described in AOAC [11]. The method of Lawrence [12] was used to determine the lactose content. Values of pH were measured with a digital pH-meter (Chemcadet Cole-Palmer, Chicago, IL) by inserting the pH electrode (Orion, MA) directly into cheese samples. Meltability and fat leakage (oil separation) of cheese samples were determined by the method of Nilson and Lacshair [13].

TABLE 2 - Formulations of different Mozzarella blends to manufacture cheese analogues (kg/100 kg).

Treatments / Ingredients	Control	T1	T2	T3
Cheese curd	0	18.50	23.08	30.43
Rennet casein	19.85	15.65	15.38	13.63
Vegetable fat	18.53	21.35	21.54	16.36
Whey proteins	0.33	0.33	0.33	0.33
Butter flavour	0.14	0.14	0.14	0.14
Modified starch	3.97	5.69	3.08	2.73
Stabilizer	0.26	0.26	0.26	0.26
Emulsifying salts	1.28	1.28	1.28	1.28
Lactic acid	1.0	1.0	1.0	1.0
Potassium sorbate	0.29	0.29	0.29	0.29
Salt	1.49	1.49	1.49	1.49
Water	52.93	34.15	31.77	31.35
Total	100	100	100	100

Free oil (%) of MCA was examined using Gerber fat testing equipment as mentioned by Zammar [14]. Texture profile of analogue samples were tested with a Universal Testing Machine (Cometech, B type, Twaiwan), provided with software. A back extrusion cell with 35-mm diameter compression disc was used. Two cycles were applied at a constant crosshead velocity of 1 mm/s to 35% of sample depth, and then returned. From the resulting force-time curve, the values for texture attributes were calculated [15]. Baking quality of resultant Mozzarella analogues were evaluated as described by Karimah [16]. Cheese analogue samples were sensorically analysed when fresh, and periodically after 2 and 4 weeks of storage according to the scheme of Nelson and Trout [17]. The data obtained of 3 replicates were statistically analyzed according to SAS [18] using General Linear Model (GLM), and Duncan's multiple range test was used to separate among means.

3. RESULTS AND DISCUSSION

3.1 Physicochemical properties of Mozzarella analogues

Data presented in Table 3 indicate that substitution of rennet casein by cheese curd in mozzarella analogue led to a significant lower amount of moisture content compared with control. This could be due to the fact that rennet casein has a high ability on binding water and tends to over-hydrate during processing of analogue cheese [19]. Total protein, fat and ash contents were lowest in control treatment compared to other treatments that contain the cheese curd.

The higher contents of protein, fat and ash in analogue cheese treatment with cheese curd in the blends are related to the higher ratios of protein resource ingredients. There was insignificant change of salt contents among all treatments including control. This was expected, since it was adjusted in the formula of all treatments before the cooking process.

TABLE 3 - Chemical composition of fresh Mozzarella cheese analogue (MCA) as affected by different substitution levels of rennet casein with cheese curd.

Composition (%)	Treatments*			
	Control	T_1	T_2	T_3
Moisture	56.78^{A}	48.53^{D}	50.04^{C}	51.37^{B}
Total protein	17.17^{C}	17.78^{B}	18.23^{A}	18.41^{A}
Fat	20^{B}	24^{A}	25^{A}	23^{A}
Ash	3.44^{C}	3.69^{B}	3.72^{B}	3.99^{A}
Salt	1.10^{A}	1.20^{A}	1.30^{A}	1.44^{A}

* Treatments, see Table 2 for details; A, B, C: Means with same letter among the treatments in the same row are not significantly different

Blending cheese curd in the base formula significantly increased the soluble nitrogen/total nitrogen content (SN/TN) compared to control (Table 4). During storage, the values of SN/TN increased in all treatments including control. The changes in SN/TN during storage could be the result of enzymatic activity of resistant proteinases present in the product. It could be also due to the effect of adding emulsifying salt which caused more solubilization of proteins. These results are in agreement with those reported by O'Malley *et al*. [9] who suggested that plasmin was the primary proteolytic agent contributing to initial hydrolysis of the caseins while microbial proteinases and peptidases may have contributed to the high levels of free amino acids in the cheese analogues. Table 4 illustrates also the changes in lactose content of MCA. Results indicated that lactose values were significantly higher in treatments with cheese curd than control treatment (without cheese curd), and treatment T_3 presented the highest among all treatments while control showed the lowest value. Lactose ratio gradually decreased in all treatments during storage of MCA, up to 4 weeks at 5±1 °C. This decrease could be attributed to the growth and activity of the microflora and/or enzyme activity in cheese curd. The findings are in agreement with El-Shibiny *et al.* [20]. Values of pH presented in Table 4 show a slight increase with increasing substitution ratio of cheese curd in formula of MCA. Therefore, T_2 treatment showed the highest pH value among all resultant analogue Mozzarella cheeses, while control had the lowest. The pH values showed a slight and gradual decrease during storage of all treatments. The decrease in pH during storage could be related to the hydrolysis occurring in lactose and emulsifying salts, and their interaction with proteins. These findings are in agreement with Awad and Salama, [21, 22]. Changes in acidity values had an opposite trend to that occurring in pH being higher in treatments of cheese curd with slight proportional increase during storage period Table 4. A similar observation was recorded by Awad [23].

TABLE 4 - Soluble nitrogen/total nitrogen (SN/TN), lactose, pH and acidity values of Mozzarella cheese analogues (MCAs) affected by different substitution levels of rennet casein with cheese curd (fresh and during storage at 5±2 °C).

Storage period (days)	Treatments*			
	Control	T_1	T_2	T_3
	SN/TN (%)			
Fresh	11.15^{Cc}	12.27^{Bc}	$12.59A^{Bc}$	13.15^{Ac}
14	13.01^{Cb}	14.08^{Bb}	$14.69A^{Bb}$	15.22^{Ab}
28	15.61^{Ca}	16.61^{Ba}	$17.48A^{Ba}$	17.99^{Aa}
	Lactose (%)			
Fresh	1.37^{Ca}	1.42^{Ca}	2.37^{Aa}	2.74^{Ba}
14	1.20^{Db}	1.27^{Cb}	2.01^{Bb}	2.45^{Ab}
28	0.95^{Cc}	1.0^{Cc}	1.74^{Bc}	1.95^{Ac}
	pH value			
Fresh	5.85	5.97	6.01	5.93
14	5.80	5.90	5.92	5.86
28	5.66	5.74	5.80	5.67
	Acidity (%)			
Fresh	0.74^{Ac}	0.68^{Bc}	0.57^{Dc}	0.60^{Cc}
14	0.80^{Ab}	0.71^{Cb}	0.67^{Db}	0.77^{Bb}
28	0.88^{Aa}	0.81^{Ca}	0.78^{Da}	0.85^{Ba}

* Treatments, see Table 2 for details; **A, B, C**: Means with same letter among the treatments in the same storage period are not significantly different; **a, b, c:** Means with same letter in the same column during storage periods are not significantly different.

3.2 Functional properties of Mozzarella cheese

Meltability or flowability is the basic characteristic of Mozzarella cheese. The term "meltability" refers to the way of melted cheese and spreads upon heating. Meltability values of MCAs were affected by replacing rennet casein with cheese curd (Fig. 1). Blending cheese curd in based formula increased the meltability values of Mozzarella analogues compared to control, fresh and during storage period. Treatment T_2 showed the highest while control treatment the lowest of meltability values. The high meltability of samples containing cheese curd may be due to the high ratio of water to protein that led to an increase of the meltability in analogue cheeses, with the excess 'unbound' water facilitating cheese particles to flow when heated [24]. The changes in meltability values among treatments would be a function of several factors, such as moisture, pH, calcium contents, and the nature of proteins in treated Mozzarella and/or casein micelle size modification. These findings are in agreement with those of Awad and Salama [22] as well as Awad *et al.* [25]. There was an improvement in melting properties of all cheeses during storage period. The increase in meltability values of stored samples could be related to the partial proteolysis and protein breakdown occurring in the cheese matrix. This could be also due to the development of acidity which increased the soluble calcium to be partly removed as well as the progression of cheese proteolysis. Changes that occurred in meltability values of treatments during storage intervals were remarkable. The results are in accordance with Awad [26] and Awad *et al*. [25].

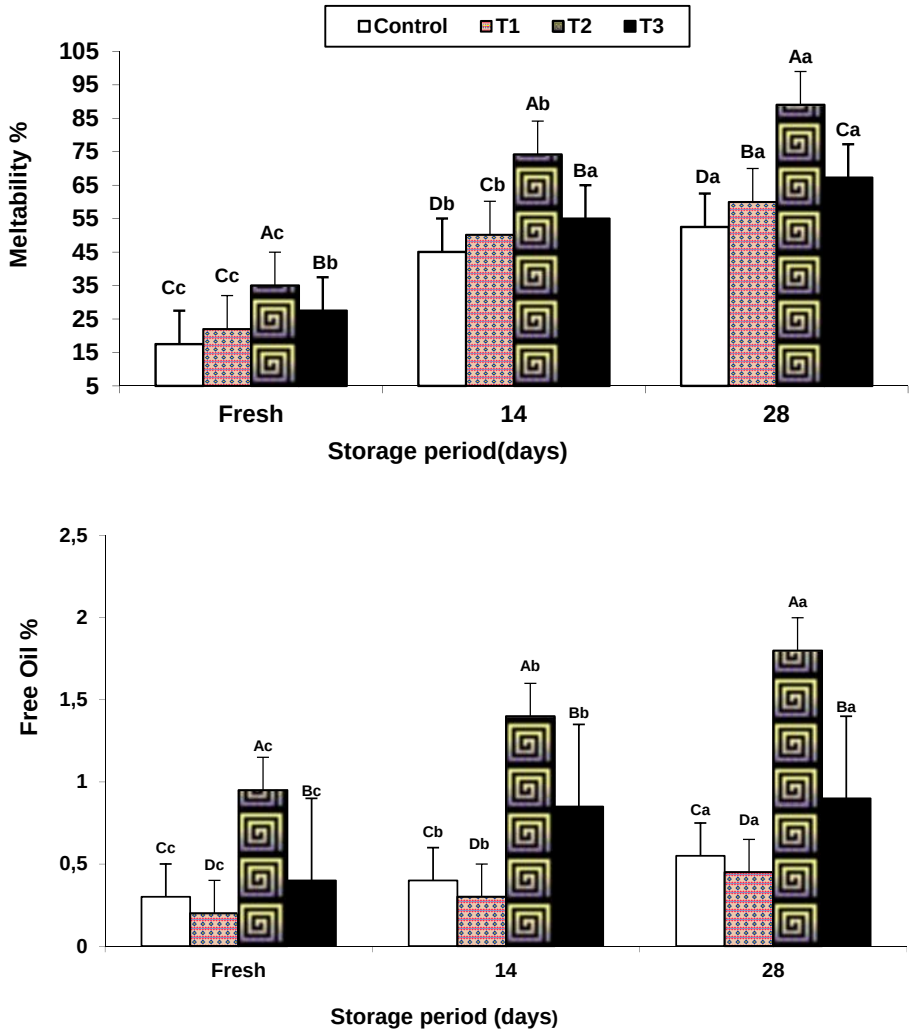

FIGURE 1 - Meltability and free oil (%) of MCAs as affected by different substitution levels of rennet casein with cheese curd (fresh and during storage at 5±2 °C). A, B, C: Means with same letter among treatments in the same storage period are not significantly different; a, b, c: Means with same letter during storage periods are not significantly different

Free oil is caused by the release from the body of melted cheese. The free oil values of MCA formulations of rennet casein and replacing it by cheese curd when fresh and during storage periods are illustrated in Fig. 1. Incorporation of cheese curd in analogue formulation led to increase of the free oil values of treatments compared to control. The results also indicated that the control treatment showed lowest while treatment T_2 had the highest free oil values. Excessive free oil results in pools of liquid fat at the surface and throughout the body of the melted cheese gave the cheese glossy appearance and mouth-feel. A moderate release of free oil contributes to desirable melting characteristics by creating a hydrophobic film on the cheese surface during baking, and slowing down evaporative loss of moisture. Excessive dehydration during melting, occurring when free oil release was insufficient, results in the formation of tough skin on the cheese surface that inhibits flow, and scorches readily [32].

3.3 Texture and rheological properties of Mozzarella

The term 'Rheology' means the study of the deformation and flow of matter. Rheology can be used as quality control tool in processing, as it has been closely correlated with the overall texture, sensory attributes of the food products, and microstructure changes during processing. The changes in texture profile analysis (TPA) of Mozzarella analogues made from rennet casein and cheese curd is shown in Table 5. The results indicate that the firmness, cohesiveness, springiness, gumminess, chewiness and resilience were significantly increased while adhesiveness decreased for treatments containing cheese curd compared to control (without cheese curd), either fresh or during storage periods. Treatment T_2 showed the highest TPA values, except adhesiveness, among all treatments including control. It could be said that differences in TPA values of blending cheese curd in formula of analogue cheeses led to increased TPA values, except adhesiveness which was decreased.

TABLE 5 - Changes in rheology parameters of MCAs as affected by different substitution levels of rennet casein with cheese curd (fresh and during storage at 5±2 °C).

Property	Storage period (days)	Treatments*			
		Control	T_1	T_2	T3
Firmness	Fresh	4.13^{Da}	4.38^{Ca}	5.24^{Aa}	4.89^{Ba}
	14	2.53^{Db}	3.52^{Bb}	4.27^{Ab}	3.38^{Cb}
	28	1.94^{Dc}	2.06^{Cc}	3.34^{Ac}	2.55^{Bc}
Adhesiveness (g/sec)	Fresh	0.58^{Ac}	0.54^{Bc}	0.36^{Cc}	0.32^{Db}
	14	0.72^{Ab}	0.66^{Bb}	0.39^{Db}	0.45^{Ca}
	28	0.96^{Aa}	0.73^{Ba}	0.56^{Ca}	0.47^{Da}
Cohesiveness	Fresh	0.59^{Ca}	0.62^{Ba}	0.67^{Aa}	0.61^{BCa}
	14	0.55^{Bb}	0.57^{Bb}	0.63^{Ab}	0.56^{Bb}
	28	0.49^{Cc}	0.54^{ABc}	0.56^{Ac}	0.52^{Bc}
Springiness (mm)	Fresh	0.64^{Da}	0.75^{Aa}	0.71^{Ba}	0.66^{Ca}
	14	0.60^{Db}	0.72^{Ab}	0.67^{Bb}	0.65^{Ca}
	28	0.51^{Cc}	0.67^{Ac}	0.56^{Bc}	0.56^{Bb}
Gumminess (g)	Fresh	2.41^{Da}	2.76^{Ca}	3.04^{Aa}	2.90^{Ba}
	14	1.24^{Db}	2.44^{Bb}	2.53^{Ab}	1.74^{Cb}
	28	1.18^{Cc}	1.19^{Cc}	1.99^{Ac}	1.72^{Bb}
Chewiness (g/mm)	Fresh	1.65^{Da}	1.95^{Ba}	2.04^{Aa}	1.86^{Ca}
	14	0.84^{Db}	1.57^{Bb}	1.77^{Ab}	1.13^{Cb}
	28	0.81^{Cc}	0.79^{Cc}	1.39^{Ac}	0.97^{Bc}
Resilience	Fresh	0.40^{Ca}	0.42^{Ba}	0.47^{Aa}	0.43^{Ba}
	14	0.35^{Cb}	0.38^{Bb}	0.43^{Ab}	0.35^{Cb}
	28	0.31^{Cc}	0.37^{Ab}	0.32^{BCc}	0.33^{Bc}

* Treatments, see Table 2 for details; A, B, C: Means with same letter among the treatments in the same storage period are not significantly different; a, b, c: Means with same letter in the same column during storage periods are not significantly different.

These results, of course, are due to status of proteins, moisture content, fat distribution; pH value and emulsifying agents with crucial importance [27]. During storage periods, the firmness, cohesiveness, springiness, gumminess; chewiness and resilience decreased in all treatments including control while adhesiveness increased. The results agree with Marshall [28] who showed that differences found in the texture of cheese analogues can be related to the way that fat and protein are distributed. A higher fat content resulted in softer, less springy, more cohesive and adhesive cheese analogues [29]. Increasing the amount of citric acid or sodium chloride caused a significant decrease in cohesiveness and springiness with an increase in firmness [30].

3.4 Baking quality

Browning is a property of cheese resulting in patches of darkened color on the cheese surface during baking, before consumption. It is widely believed that the browning of cheese during baking is mainly caused by Maillard reactions which involve an interaction between reducing sugars and amino compounds. Figure 2 shows baking colour and quality of MCAs from different formulations, with or without cheese curd. White color is the most dominant with little of yellow in control treatment: In treatment T_1 more dark, red and yellow color with little white color, in T_2 equal red and yellow with little white color, and in T_3, more red and white with little yellow color are dominant. The treatment T_2 showed the best baking quality, followed by T_1, then T_3, and control treatment as last one. These differences in color from red to yellow and white may be due to incomplete fermentation of lactose, which possibly will result in the presence of galactose which is a major determinant of browning. Mozzarella cheese that contains both reducing sugars and proteolytic products is susceptible to Maillard browning at high temperatures, such as pizza baking [31, 32]. Baking of Mozzarella analogue treatments with rennet casein and cheese curd indicated incorporation of cheese curd in the formula improving the baking quality of the resultant Mozzarella analogue. Therefore, it could be recommended to substitute the added rennet casein in Mozzarella analogue partially with cheese curd to get better quality during baking of pizza pie.

3.5 Sensory quality attributes

The sensory evaluation score for different formulations of mozzarella analogues is represented in Table 6.The outer appearance of treatments with cheese curd was more acceptable than that of control without cheese curd. Treatment T_2 was significantly higher in appearance than control, fresh and also during storage period. Body and texture of analogue cheeses was much better with blending cheese curd in formulations than control without cheese curd. Substitution of rennet casein by cheese curd led to a significant improvement in body and texture of MCAs. Incorporation of cheese curd also improved the flavor in analogue cheese with regard to control without cheese curd. Total score was also higher in analogue cheese containing cheese curd than

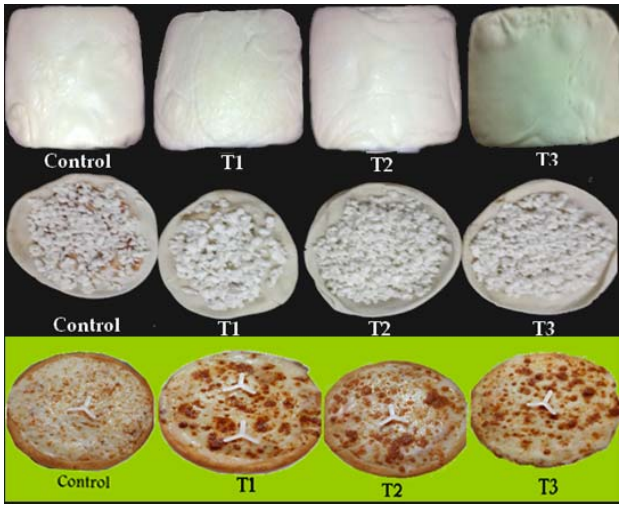

FIGURE 2 - Photos of different Mozzarella cheese analogues (MCAs) with rennet casein substitution by cheese curd, and their effects during pizza baking

TABLE 6 - Sensory quality attributes of Mozzarella cheese analogues (MCAs) as affected by different substitution levels of rennet casein with cheese curd (fresh and during storage at 5±2 °C).

Storage period (days)	Properties		Treatments*			
			Control	T_1	T_2	T3
Fresh	Flavour	(50)	43^{Dc}	46^{Bc}	47^{Ac}	45^{Cc}
	Body&texture	(35)	28^{Cc}	32^{Bb}	34^{Ab}	32^{Bc}
	Appearance	(15)	10^{Cb}	13^{Ba}	14^{Aa}	13^{Ba}
	Total	(100)	81^{Dc}	91^{Bc}	95^{Ac}	90^{Cc}
14	Flavour	(50)	45^{Db}	47^{Bb}	48^{Ab}	46^{Cb}
	Body & texture	(35)	32^{Db}	34^{Ba}	35^{Aa}	33^{Cb}
	Appearance	(15)	12^{Ca}	13^{Ba}	14^{Aa}	13^{Ba}
	Total	(100)	89^{Db}	94^{Bb}	97^{Ab}	92^{Cb}
28	Flavour	(50)	46^{Da}	48^{Ba}	49^{Aa}	47^{Ca}
	Body & texture	(35)	33^{Ca}	34^{Ba}	35^{Aa}	34^{Ba}
	Appearance	(15)	12^{Ca}	13^{Ba}	14^{Aa}	13^{Ba}
	Total	(100)	91^{Da}	95^{Ba}	98^{Aa}	94^{Ca}

* Treatments, see Table 2 for details; A, B, C: Means with same letter among the treatments in the same storage period are not significantly different; a, b, c: Means with same letter in the same column during storage periods are not significantly different.

without cheese curd. The sensory quality of all cheeses was continuously and gradually improved during storage period reaching the highest score at the end of storage period (4 weeks) at 5±2 ºC. These improvements during storage may be attributed to the partial proteolysis of cheese protein leading to more soft body & texture as well as flavour enhancement. The results coincide with those of Abd El-Hamid *et al.* [33], El-Batawy *et al.* [34], Awad *et al.* [35] and Awad [26]. Sensory assessment of Mozzarella analogues of different formulations indicated that partial substitution of rennet casein in the blend with cheese curd improved all sensory attributes being the best in formula T_2 with 23% cheese curd plus 15.5% rennet casein in the blend.

4. CONCLUSION

Mozzarella cheese analogue could be effectively formulated with cheese curd (different substitution levels) for rennet casein. Blending cheese curd in formulations led to an improvement of functional properties of Mozzarella cheese analogues, such as meltability, free oil, rheological, and sensory evaluation properties. Furthermore, it is a low-cost process when compared to traditional Mozzarella cheese.

The authors have declared no conflict of interest.

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CORRESPONDING AUTHOR

Mahmoud A. Mailam
Food Technology Research Institute
Agriculture Research Center
El-Giza
EGYPT

E-mail: m_mailam@yahoo.com
mahmoudmailam@yahoo.com

AFS Book Reviews Bücherschau

DLG-Futterwerttabellen Schweine -
Eine Information des DLG-Arbeitskreises Futter und Fütterung

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7. erweiterte und völlig neu gestaltete Auflage, 2014; **68** Seiten, zahlreiche Tabellen; erhältlich bei DLG-Verlags-GmbH, Eschborner Landstraße 122, 60489 Frankfurt am Main, Tel.: 06123/9238-263; Fax: 06123/9238-262; E-Mail: dlg-verlag@DLG.org oder im Online-Buchshop: www.dlg-verlag.de (Pressekontakt - E-Mail: h.mentzel@DLG.org; Tel.: 069/24788-478) oder im Buchhandel; **ISBN 978-3-7690-0664-3**; **€ 29,90** (D) / € 30,80 (A) / sFr 49,50

Für eine bedarfsgerechte und erfolgreiche Fütterung von Schweinen ist die Kenntnis des Futterwertes der eingesetzten Futtermittel unerlässlich. Eine sehr gute Hilfe dafür sind die „**DLG-Futterwerttabellen – SCHWEINE**". Die DLG (Deutsche Landwirtschafts-Gesellschaft) gab nun die lang erwartete 7. Auflage heraus. Seit der 6. Auflage aus dem Jahr 1991 sind über 20 Jahre vergangen! Die Veränderungen machten eine umfangreiche Erweiterung und Überarbeitung erforderlich.

So veränderten sich in der Schweinehaltung z.B. Erbgut und Produktionsverfahren erheblich. Höhere biologische Leistungen erforderten eine Neuberechnung der Versorgungsempfehlungen. Die Futterbewertung wurde hinsichtlich der Berechnung des Gehalts an umsetzbarer Energie auf der Basis der verdaulichen Rohnährstoffe weiterentwickelt. Zudem waren neue Erkenntnisse zum Bedarf an Protein und Aminosäuren zu berücksichtigen. Einige in der Schweinehaltung eingesetzte Futtermittel veränderten sich im Lauf der Jahre. Dies kann preisliche Ursachen haben, aber auch durch futtermittelrechtliche Änderungen oder Anforderungen der Kunden verursacht sein. Auch solchen Veränderungen tragen die Tabellen Rechnung.

Die Anzahl der den Futterwert charakterisierenden Parameter wurde von bislang 20 auf 30 erhöht. Für jedes Futtermittel werden nun die Gehalte bezogen auf die Originalsubstanz (Frischmasse) und bezogen auf die Trockenmasse dargestellt. Ferner sind die Futtermittel neu geordnet und in Anlehnung an Futtermittelrecht und Positivliste Einzelfuttermittel in 10 Gruppen gefasst worden.

Es werden die in der Praxis relevanten Futtermittel nach den neuesten Erkenntnissen in ihren Nährstoffgehalten und Verdaulichkeiten beschrieben und übersichtlich dargestellt. Neu mit aufgenommen wurden Gehalte an Aminosäuren, Mineralstoffen und Faserstoffen sowie Verdaulichkeiten von Phosphor und Aminosäuren. Dem Tabellenteil vorangestellt sind aktuelle Orientierungswerte für die Versorgung von Sauen, Ferkeln, Mastschweinen und Jungmastebern mit Energie und Nährstoffen.

Die Futterwerttabellen sind für Schweinehalter, Berater, Futtermittelhersteller, Tierärzte und alle an der Schweinefütterung Interessierten ein wichtiges und nützliches Werkzeug zur Einschätzung des Futterwertes von Einzelfuttermitteln und zur Kalkulation von bedarfsgerechten Futterrationen.

AFS Press Release

Teilflächen bewirtschaften - Schritt für Schritt

Auf einem Ackerschlag wachsen die Pflanzen oft unterschiedlich gut. Doch wann sind die Unterschiede groß genug, damit sich eine teilschlagspezifische Bewirtschaftung lohnt? Welche Gründe haben die Unterschiede? Sind es natürliche Ursachen, gibt es Möglichkeiten den Standort zu verbessern oder liegt es an der Bewirtschaftung? Ist es notwendig, den Betriebsmitteleinsatz anzupassen? Wie grenzt man Teilflächen ab, und wie werden sie anschließend bewirtschaftet? Überhaupt: Wie fängt man am besten an, was wird gebraucht und mit wem kann man zusammenarbeiten?

Im neuen Buch „**Teilflächen bewirtschaften**“ aus dem DLG-Verlag finden die Leser dazu Ideen, Anregungen und Entscheidungsgrundlagen. Sie erfahren, wie sie Schritt für Schritt die erforderlichen Maßnahmen umsetzen und wie sich die Investition bezahlt macht. Die Autoren konzentrieren sich auf sogenannte Offline-Anwendungen. Das bedeutet: Teilschlagspezifische Maßnahmen werden anhand von Entscheidungskriterien geplant, die zu einer Anwendungs- oder Applikationskarte führen. Die Planung ist von der Ausführung zeitlich getrennt.

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Der Band erscheint in der Ratgeber-Reihe „**AgrarPraxis kompakt**“ des DLG-Verlags: Praktisches Wissen – kurz, übersichtlich und einfach verständlich erklärt. Klein, praktisch, vielseitig, preisgünstig – die kleinen Helfer von Spezialisten für Praktiker.

Frank Lorenz u. Klaus Münchhoff: Teilflächen bewirtschaften - Schritt für Schritt
1. Aufl. 2015, 120 Seiten, kartoniert, zahlr. farb. Abb.; ISBN 978-3-7690-2040-3; € 7,50 (D) / € 7,70 (A) / sFr 12,00 (**Erhältlich** in allen Buchhandlungen und bei: DLG-Verlag GmbH, Eschborner Landstraße 122, 60489 Frankfurt am Main; Telefon: 0 61 23/92 38 263; Fax: 0 61 23/92 38 262; E-Mail: dlg-verlag@DLG.org; Online-Buchshop: www.dlg-verlag.de; **Pressekontakt:** E-Mail: h.mentzel@DLG.org, Telefon: 0 69/2 47 88-478

Aus dem Inhalt: Wann lohnt sich die Teilfläche? ● Voraussetzungen für den Einstieg (Ziele, Infos, Software, digitale Karten, digitale Schlaggrenzen, globale Navigationssatellitensysteme, Technik, Schulungen) ● Vom Schlag zur Teilfläche (beschreibende Infos, erklärende Infos, Standortpotenzialkarten, Zusammenarbeit mit Dienstleistern usw.) ● Wie werden teilflächenspezifische Karten eingesetzt? (Kalkung und Grunddüngung – Beprobungen, Bodenuntersuchungsergebnisse, Ausbringungskarten, Bodenbearbeitung, Aussaat, Beregnung, Drusch) ● Wirtschaftlichkeit & Management (Kosten und Nutzen, Kompatibilität zwischen Hof-PC und Jobrechnern auf den Maschinen, Datenmanagement)

Fortschritt nutzen – Zukunft gestalten - Für eine moderne, nachhaltige Landwirtschaft
(Band zur DLG-Wintertagung 13. bis 15. Januar 2015 in Berlin)

Ein rasanter Fortschritt prägte die Landwirtschaft in den vergangenen Jahrzehnten. Innovationen in Landtechnik, Pflanzenzucht und Tierhaltung gehörten zu den Triebfedern. Die Elektronik eröffnete neue Möglichkeiten in Produktionssteuerung, Betriebsanalyse und -management. Auf der anderen Seite erscheint das Verhältnis zwischen Landwirtschaft und Gesellschaft zunehmend spannungsgeladen. Die Gesellschaft sieht diesen Fortschritt eher kritisch. Sie verbindet mit der konsequenten Nutzung auch negative Facetten wie ungenügenden Tierschutz, Belastung von Umwelt und Natur oder Verlust von Agrarlandschaften mit ihren dörflichen familiären Strukturen.

Wie halten es die Deutschen heute mit Fortschritt und Neuerungen? Leben wir in eher fortschrittsfeindlichen Zeiten? Wie kann sich die Landwirtschaft auf die Erfordernisse der Zukunft erfolgreich einstellen? Vor welchen Herausforderungen stehen Pflanzenproduktion und Tierhaltung und mit welchen Innovationen können sie bewältigt werden? Wie sehen Ansatzpunkte für einen alternativen Fortschritt aus? Lässt sich die Notwendigkeit von Innovationen und Fortschritt besser vermitteln?

Diese und weitere Fragen stehen im Mittelpunkt der DLG-Wintertagung 2015 in Berlin. In den Beiträgen des neuen Bandes „**Fortschritt nutzen – Zukunft gestalten**“ aus dem DLG-Verlag werden die Bedeutung von Fortschritt, seine Entwicklung sowie Konfliktfelder und Lösungswege gezeigt. Aufschlussreich ist unter anderem eine aktuelle Studie über Konflikterfahrungen junger Landwirte und Landwirtinnen, wie sie Lösungsansätze sehen und welche Gründe Konfliktlösungen erschweren. Die Autoren sind Referenten der Wintertagung und namhafte Fachleute aus Wissenschaft, Agrarwirtschaft, landwirtschaftlicher Unternehmensberatung und Meinungsforschung, Experten für Wissenschafts-Kommunikation sowie für Politik- und Gesellschaftsberatung.

Das Buch ist eine wertvolle Orientierungshilfe für Praktiker und für die Verantwortlichen in der Agrarwirtschaft, in Politik, Verwaltung, Beratung und Wissenschaft.

DLG e.V. (Hrsg.): **Fortschritt nutzen – Zukunft gestalten Für eine moderne, nachhaltige Landwirtschaft**

1. Aufl. 2015, 240 Seiten, kartoniert, zahlr. farb. Abb. u. Grafiken; ISBN 978-3-7690-4074-6; € 26,00 (D) / € 26,80 (A) / sFr 41,60; Erhältlich in allen Buchhandlungen und bei: DLG-Verlag GmbH, Eschborner Landstraße 122, 60489 Frankfurt am Main, Telefon: 0 61 23/92 38 263, Fax: 0 61 23/92 38 262, E-Mail: dlg-verlag@DLG.org, und im Online-Buchshop unter: www.dlg-verlag.de; Pressekontakt: E-Mail: h.mentzel@DLG.org, Telefon: 0 69/2 47 88-478

Aus dem Inhalt: Fortschritt in der Kritik: Zeitgeist oder Zeitenwende? • Die Deutschen und der Fortschritt • Innovationen in der Pflanzenzüchtung zur Bewältigung zukünftiger Herausforderungen • Alternativer Fortschritt – Gemeinwohlökonomie als neues Wirtschaftsmodell? • Neuausrichtung der ländlichen Entwicklungspolitik – Demografischer Wandel und seine Konsequenzen • Zwischen Verdrängungswettbewerb und Optimismus – was bestimmt die Perspektiven für 2025? • Nachhaltigkeit und Innovation – zwei Seiten einer Medaille? Nachhaltigkeit als Kommunikationsfaktor • Spannungsfeld Landwirtschaft und Gesellschaft – Konflikterfahrungen und Lösungsansätze junger Landwirte.

Konformitätsarbeit für Lebensmittelverpackungen

Fresenius-Intensivseminar mit Workshops
am 27. und 28. April 2015 in Mainz:
Grundlagen der Konformitätsarbeit -
Rechtliche Aspekte – Praxisberichte

Kenntnisse über Konformitätserklärungen werden in der Lebensmittelbranche von Arbeitnehmern unterschiedlichster Arbeitsbereiche benötigt: Neben Einkäufern von Verpackungsmaterialien kommen auch Fach- und Führungskräfte aus der Lebensmittelherstellung sowie der Qualitätssicherung, der Rechtsabteilung, der Produktentwicklung und dem Marketing mit dem Thema in Kontakt. Umso wichtiger ist es für Unternehmen, die erforderlichen Fachkenntnisse zum richtigen Umgang mit den Schriftstücken auf breiter Basis sicherzustellen. Einen kompakten, praxisorientierten Überblick über die Konformitätsarbeit für Lebensmittelverpackungen vermittelt ein Intensivseminar der Akademie Fresenius am 27. und 28. April 2015 in Mainz.

Das Intensivseminar behandelt alle wesentlichen Aspekte der Konformitätsarbeit: Der Veranstaltungsteil "Grundlagen" klärt über gesetzliche Vorgaben, das Konzept der Konformitätsarbeit über eine komplexe Herstellerkette sowie über Möglichkeiten auf, gesundheitliche Unbedenklichkeit nachzuweisen. Details zu rechtlichen Fragestellungen erfahren die Teilnehmer darüber hinaus im Rahmen eines weiteren Themenbereichs, der auch die Sicht der Überwachung beleuchtet. Der Bereich widmet sich unter anderem Fragen nach Haftungsrisiken und Handlungsoptionen bei Stoffmigration und dem Vorgehen bei der behördlichen Überprüfung von Konformität. Ergänzend präsentiert die Veranstaltung Praxisberichte, mit Beiträgen zur Schweizer Checkliste und deren Zusammenhang mit dem IFS Verpackungsleitfaden, zu Vor- und Nachteilen von Checklisten, der Konformitätsarbeit in der täglichen Praxis und ihren natürlichen Grenzen. Im Rahmen der integrierten Workshops trainieren die Seminarteilnehmer, Konformitätserklärungen richtig zu lesen, sie zu beurteilen und zu überprüfen.

Referenten:
- Dr. Angela Berner, Wipak Walsrode
- Dr. Christophe Goldbeck, Chem. u. Veterinäruntersuchungsamt Münsterland-Emscher-Lippe
- Dr. Thomas Gude, SQTS-Swiss Quality Testing Services
- Dr. Konrad Grob, Kantonales Labor Zürich
- Dr. Stefanie Hartwig, Zenk Rechtsanwälte
- Kathrin Schönfelder, Landesunters.anstalt für das Gesundheits- u. Veterinärwesen Sachsen

Das komplette Programm im Internet unter:
www.akademie-fresenius.de/2244
Termin: 27. - 28. April 2015
Ort: Mainz

Kontakt: Die Akademie Fresenius GmbH
Annika Koterba
Alter Hellweg 46
44379 Dortmund
Telefon: 0231-75896-74
Fax: 0231-75896-53
akoterba@akademie-fresenius.de
http://www.akademie-fresenius.de

TÜV SÜD erklärt neue Proteinquellen

Zur Zukunftssicherung der weltweiten Ernährung muss die Welt die Produktion der Nahrungsmittel bis 2050 verdoppeln. In neue Eiweißquellen wird viel Hoffnung gesetzt, nicht zuletzt wegen der zum Teil günstigeren Bilanz an natürlichen Ressourcen. Die Experten von TÜV SÜD zeigen, was hinter den Produkten aus Soja, Lupinen, Insekten & Co. steckt.

Auch wenn der Reagenzglas-Burger für alle noch teuerste Zukunftsvision ist: Forscher sind auf der Suche nach neuen Eiweißquellen längst fündig geworden. Das Ziel der zu sichernden Welternährung fest im Blick, wird das Angebot innovativer Eiweiße für die menschliche Ernährung immer bunter. Doch was steckt hinter diesen Produkten?

Die wohl bekannteste Alternative für Fleischeiweiß ist Tofu aus Sojabohnen. Die Herstellung hat eine jahrtausendealte Tradition: Eingeweichte Sojabohnen werden gemahlen, gefiltert und mit Hilfe von Ferment zum Gerinnen

gebracht. Das ausgeflockte Sojaeiweiß wird in Blöcke gepresst und kommt pasteurisiert und vakuumverpackt in den Handel. Die Rohvariante ist relativ geschmacklos und hat keine fleischähnliche Konsistenz. Ganz anders ist das sogenannte texturierte Sojaprotein, das als Trockengranulat heute schon mit seiner faserigen Struktur eine beliebte fleischfreie Grundlage für Bolognese, Gulasch oder Burger in vegetarischen und veganen Kreisen ist.

Ein neuer Eiweißlieferant ist auch das Lupineneiweiß. Den entölten Lupinensamen werden zunächst über mehrere Stufen Kohlenhydrate und Fasern entzogen. Die so entstandene „Milch" wird als Basis zu milchfreiem Speiseeis oder getrocknet zu Fleischersatzprodukten weiterverarbeitet. Glutenfreie Backmischungen, fettarme Wurst und „Eiweißbrote" mit Lupinenprotein sind heute schon auf dem Markt.

Faserreich und daher oft als „Weizenfleisch" bezeichnet hält auch das asiatische Seitan Einzug in europäische Küchen. Durch Wässern und Kneten wird die Stärke aus Weizenmehl ausgewaschen, so dass am Ende ein faseriger Proteinblock entsteht, der mit Gewürzen und Sojasoße mariniert und gekocht zu fleischfreiem Schnitzel oder Gyros weiterverarbeitet werden kann. Ähnlich wie bei den anderen neuen Proteinquellen ist der Produktionsaufwand sehr hoch. Nährstoffe wie Vitamine, Mineralstoffe oder sekundäre Pflanzenstoffe bleiben weitgehend auf der Strecke.

Viele der neuen Proteinquellen besitzen kaum Eigengeschmack und werden in Folge oft mit Marinaden, Gewürzmischungen, Hefen und Aromen gewürzt. Auf Soja und Lupinen sind manche Menschen allergisch, weshalb bei der Zutatendeklaration gezielt darauf hingewiesen werden muss.

Auch Insekten können zum menschlichen Verzehr genutzt werden. Diese spielen in der Europäischen Küche bisher keine Rolle und haben eher exotischen Event-Charakter in kleinem oder touristischem Maßstab.

Viele Insektenarten haben zwar hochwertige Proteine kombiniert mit anderen Nährstoffen. Dr. Andreas Daxenberger, Lebensmittelexperte von TÜV SÜD, verweist jedoch darauf, dass die Einordnung der Insekten als Lebensmittel in Europa noch gesetzliche Grauzone ist: „So ist unklar, ob Insekten als Ganzes Lebensmittel sind oder in der EU dem Zulassungsverfahren nach Novel Food-Verordnung unterliegen. Für zum Beispiel aus Tieren isolierte Lebensmittelzutaten, die nicht mit herkömmlichen Vermehrungs- oder Zuchtmethoden gewonnen wurden, ist dies heute schon geregelt." Zur gezielten Produktion von Insekten zum menschlichen Verzehr sind wichtige Gesundheits-, Rechts- und Qualitätssicherungsfragen ungeklärt. „Bei den Insekten oder Insektenmehl ist derzeit völlig offen, welche Formen der Tierhaltung, der Betriebshygiene, der Verarbeitung und Lagerung überhaupt geeignet sind, um die Gesundheit des Verbrauchers angemessen zu schützen." Auch müssen z. B. allergische Reaktionen auf Insekteneiweiß geprüft werden.

Neue Proteinquellen fassen derzeit zwar in Europa erstmals Fuß, sind aber ein Nischenangebot. Ein breites und gesichertes Anwendungsfeld für die Proteine dieser besonderen Art ist im europäischen Lebensmittelrecht nicht vorgesehen – ganz im Gegensatz zur Produktion von bewährten Proteinquellen aus der konventionellen oder auch ökologischen aus Fleischerzeugung bzw. pflanzlicher Produktion.

Weitere Informationen zu TÜV SÜD unter www.tuev-sued.de/sichere-lebensmittel.

TÜV SÜD auf dem 7. Food Safety Kongress in Berlin - Lebensmittelsicherheit im Fokus

Die Lebensmittelwirtschaft steht durch politische Entwicklungen, Kundenerwartungen sowie globale Warenströme vor großen Herausforderungen. Nur wenn sie entlang der gesamten Wertschöpfungskette die Sicherheits- und Qualitätsbestimmungen einhalten, können sie Image und Erfolg ihres Unternehmens wahren. Auf dem Food Safety Kongress am 24. und 25. Februar 2015 in Berlin informieren Experten wie Dr. Andreas Daxenberger von der TÜV SÜD Management Service GmbH über Themen rund um die Lebensmittelsicherheit.

Schwerpunktmäßig wird beleuchtet, welche Inhalte von TTIP die Lebensmittelbranche betreffen, welche Bedeutung dies hat, wie Viren auf Lebensmitteln festgestellt und analysiert werden können beziehungsweise welche Maßnahmen zur Qualitätssicherung möglich sind. Außerdem sind Lebensmittelbetrug und Food Safety im E-Commerce wichtige Themen.

Die Lebensmittelexperten von TÜV SÜD wissen, was Lebensmittelhersteller und Einzelhändler für die Einhaltung von Sicherheitsstandards in ihrem gesamten Dienstleistungsspektrum tun können. Mit diesem Know-how stehen sie als Ansprechpartner in der Fachausstellung des Food Safety Kongresses für Fragen rund um die Lebensmittelsicherheit zur Verfügung.

Weitere Informationen zum Thema Lebensmittelsicherheit finden Interessenten unter www.tuev-sued.de/lebensmittelsicherheit.

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