

Physical characteristics of functional biscuits enriched in einkorn flakes

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Abstract

Keywords:

Einkorn
Flaking
Functional
Biscuits

Article history:

Received
29.01.2018
Received in revised
form 26.05.2018
Accepted
29.06.2018

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Introduction. The modern tendencies related to the consumption of functional food suggest that the einkorn is a cereal which can play an important role in human nutrition.

Materials and methods. The following basic materials were used for the production of biscuits: whole grain einkorn (*Triticum monoccocum* L.) flour and einkorn flakes. The manufacturing of the biscuits, as well as the determination of their physical properties (baking loss and volume) was carried out according to AACC Method 10-50D. Biscuits color was determined by spectral method using tintometer produced by Lovibont Tintometer RT 100 Colour in the CIE Lab system.

Results and discussion. During the baking, water present in the formed dough evaporates which gives biscuits of characteristic structure. The greatest baking losses showed the biscuits made from 100% einkorn flour (15.16±1.01%) and the smallest – these made from 100% einkorn flakes (9.54±1.22%), with the difference between the two samples being 5.62%.

The results obtained for the baking losses of the biscuits made from 100% flakes produced are statistically significant ($p < 0.05$).

The data on the volume of the biscuits produced show that the largest volume had the biscuits made from 100% einkorn flour (79.00±0.50 cm³).

All the samples of biscuits had colors in the green and yellow spectrum and the lightest ones were these produced from 100% einkorn flakes.

The differences between the individual samples were insignificant.

Conclusions. The increase of the amount of einkorn flakes added to einkorn flour results in slightly lower baking losses and volume of baked biscuits, and a lighter biscuits color.

DOI:

10.24263/2310-
1008-2018-6-1-4

Introduction

The modern tendencies related to the consumption of functional food suggest that the einkorn is a cereal which can play an important role in human nutrition. This is especially true by the development of new specialized nutritional products of higher quality with respect to their nutritional value. In modern world, the food we consume must, besides providing the necessary energy and nutrients, also have positive effect on human health [1].

Consumer interest in healthy eating is targeted on certain foods and food ingredients [2].

Einkorn was domesticated more than 10 000 years ago, most probably in the Karakadak mountains in southeastern Turkey and its cultivation spread to Europe during the agricultural revolution. Nowadays, einkorn is grown in the mountain regions of the mediterranean (Turkey, Balkan countries, southern Italy, southern France, Spain and Morocco). Recently, the tendency toward development of sustainable agriculture has elad to increased attention to the nutritious aspects of food. This resulted in rediscovery of some forgotten cultures like einkorn. Despite the low yield (about trice less than bread wheat), Regardless of its low yields (about a third from the bread wheat), there has been significant recovery of the cultivation of this kind of wheat in some countries (France, Germany, Austria, Hungary, Bulgaria and Italy) [3].

Einkorn (*Triticum monococcum* L. ssp. *monococcum*) is a diploid species ($2n=2x=14$ chromosomes) of hulled wheat and it is close relative of durum wheat. Recent studies highlight its good nutritional qualities when consumed by humans [4,5].

Lately, the flaked products are more and more widely used. They are contained in many food products used as snacks. They are used as supplement in bread, bakery and confectionery, including the production of biscuits [6].

The process of preparation of flaked products is as follows:

1. Cleaning and sorting – before the processing, cereals are cleaned and sorted. Cleaning removes unwanted ingredients like grain from other crops, pebbles, sand, etc. simultaneously, the grains are sorted according to their quality. The shriveled, broken and unripe grains are removed by blowing with hot air.
2. Hulling – the aim is to remove the hull of the grains and obtain dehulled ones. This is done by rolling between rubber belts (rolls) so the hull is removed without damaging the kernel. The kernels are then blown with air to remove the remaining hulls.
3. Brushing – the dehulled grains are the brushed with brushes.
4. Heating – the grains are heated to 100°C in special furnaces. By t his operation, the surface moisture increases and condenses. The vapor obtained deactivates the enzymes contained in the grains. The starch turns to paste.
5. Drying and fractionation – drying is carried out in special desiccators where the moisture content in the grains decreases and they can now be stored. The, the grains are separated into two fractions according to their size.
6. Rolling – by this process, flakes of various sizes are obtained by pressing the grains between rolls. The process of rolling involves the use of water vapor which softens the grains.
7. Drying and packing –the flaked products should be dried before packing until moisture content in them remains ca. 11%; then they are packed in suitable packings [7].

Biscuits are bakery products which most often are made from flour, fats and sugar. Various types of biscuits are offered on the market but today, when people wish to eat healthy food, it is necessary to produce “functional” biscuits [8].

It is considered that biscuit production accounts for an important part of the food industry production in most countries around the world. They have great nutritional value, especially when the raw materials used for their production are rich in fats and proteins [9]. Their important role and importance can be attributed to at least four key factors: Тяхното важно място и значение, може да се дължи най-малко на четири ключови фактора: relatively long shelf life; great variety; human desire and predisposition to sugar and chocolate, as well as their comparatively low price [10].

The aim of the present paper is to study the effect of flaked einkorn (*Triticum monococcum* L.) on some physical properties in biscuits produced from whole grain einkorn flour (base flour) to which einkorn flakes are added in quantities 30%, 50%, 70% and 100% at the expense of the base flour.

Materials and methods

Materials

The following materials were used for the production of biscuits: whole grain einkorn (*Triticum monococcum* L.) flour and flaked einkorn produced in the Plovdiv region, saccharose and glucose in the form of glucose solution (as sweeteners), cow butter, sodium bicarbonate and cooking salt – purchased from the market, drinking water from the public water supply network complying with the requirements of Regulation № 9 [11].

Methods

Production of biscuits

The manufacturing of the biscuits, as well as the determination of their physical properties (baking loss and volume) was carried out according to AACC Method 10-50D [12].

Colours of biscuits

Biscuits color was determined by spectral method using tintometer produced by Lovibont Tintometer RT 100 Colour in the CIE Lab system. The average of several measurements was taken. The general change of color was calculated by formula (1) [13].

$$\Delta E = \sqrt{(L - L_0)^2 + (b - b_0)^2 + (a - a_0)^2} \quad (1)$$

where: the indicators with index 0 refer to the baked biscuits and the other ones – to the raw dough.

The parameter ΔE shows the relationship between the human perception of biscuit color and the total change of color (Table 1).

Table 1
Relationship between the human perception of biscuit color and the total change of color (ΔE)
 [14]

Human perception	(ΔE)
No great difference	<2
Very small perceptible difference	$0.2 \div 1$
Small perceptible difference	$1 \div 3$
Medium perceptible differences	$3 \div 6$
Great perceptible differences	>6

Statistical analysis

The results obtained from the analyses are presented in tables and figures and their statistical processing was performed using XL Stat and Microsoft Excel 2013. In the XL Stat software, the analysis of the main factors (Main effects ANOVA) was employed, as well as the Fisher criterion for the least statistically significant differences (LSD) at significance factor of 95% ($p < 0.05$).

Results and discussion

The innovations in the production of biscuit applied in the recent decade are oriented to the making of biscuits with reduced content of sugars, substitution of sugars with sweeteners, use of fats of different properties, as well as enrichment of the biscuits with additives with functional properties [8]. Table 2 shows some physical characteristics (baking loss and volume) of the biscuits manufactured.

Physical characteristics of biscuits

Table 2

Biscuits/Properties	Baking loss (%)	Volume (cm ³)
100%E	15.16±1.01 ^a	79.00±0.50 ^a
70%E + 30%EF	14.10±0.52 ^a	53.00±1.48 ^b
50%E + 50%EF	12.98±0.63 ^b	52.93±1.33 ^b
30%E + 70%EF	13.03±0.96 ^{ab}	52.33±1.27 ^b
100%EF	9.54±1.22 ^b	51.33±1.53 ^b

E – einkorn flour; EF – einkorn flakes. **The data presented are the average of 5 consecutive measurements±the standard deviation. *Values in the same column with different exponents (a-b) have statistically significant difference ($p < 0.05$) ANOVA, Fisher's LSD.*

During the baking, water present in the formed dough evaporates which gives biscuits of characteristic structure [14,15]. It can be seen from Table 2 that the greatest baking losses showed the biscuits made from 100%E (15.16±1.01%) and the smallest – these made from 100%EF (9.54±1.22%), with the difference between the two samples being 5,62%. I.e., the use of EF for production of biscuits results in decrease of the losses by the baking of the final product. It was found also for the samples made from combination of flour and flakes that the baking losses decrease insignificantly with the increase of einkorn flakes content in biscuit composition. One exception from the general tendency are the biscuits containing 70%EF but the difference compared to the previous sample (50%EF) is quite small and within the standard deviation. The results obtained for the baking losses of the biscuits made from 100%EF are statistically significant ($p < 0.05$).

The data on the volume of the biscuits produced (Table 2) show that the largest volume had the biscuits made from 100% einkorn flour (79.00±0.50 cm³). These data are statistically significant compared to the others ($p < 0.05$). It was established also that even with the smallest amount of einkorn flakes added (30%), the volume of the biscuits manufactured significantly decreases compared to these made from 100% einkorn flour (the volume decreased by 26 cm³). The increase of the einkorn flakes content above 30% resulted in insignificant decrease of biscuit volume.

The values of biscuits color measured by the CIE L*a*b* system are presented in Table 3.

Table 2

Colour of biscuits measured with CIE Lab system

Biscuits/Parameter	L*	a*	b*	ΔE
100%E	49.81±1.82	2.79±1.75	22.53±2.92	6.02±0.02
70%E + 30%EF	48.47±0.21	4.34±1.83	23.54±2.42	5.44±2.32
50%E + 50%EF	48.48±1.28	2.86±1.80	21.60±3.17	5.00±2.22
30%E + 70%EF	48.49±1.52	4.86±0.97	23.99±1.55	4.85±2.18
100%EF	54.01±2.11	3.03±0.04	20.61±0.06	4.23±1.40

*E – einkorn flour; EF – einkorn flakes. **the data presented are the average of 5 consecutive measurements±standard deviation

The parameter L* show the lightness of the color. The closer its value is to zero, the darker is the color of the object studied. If the value of this parameter is close to 100, then the object studied looks brighter [16]. As can be seen from Table 3, the values of color of the biscuits produced from mixture of E+EF were almost the same but lower than these for the samples made from 100% einkorn and 100% einkorn flakes, i.e. the latter appear lighter. The highest values of this parameter had the biscuits made from 100%EF (54.01±2.11), i.e. they were the lightest while the lowest values showed the biscuits produced from 30%E and 70%EF (48.49±1.52), i.e. they were the darkest.

The value of the parameter a* in the CIE L*a*b* system define whether the color of the object studied is red or green. If the value of this parameter is positive then the color of the object studied is green, if they are negative, then the color of the biscuits is red [16]. It can be seen from the Table that the highest value of this parameter had the biscuits made

from 30%E and 70%EF (4.86 ± 0.97) and the lowest value – these made from 100%E (2.79 ± 1.75) but the differences are quite small. Obviously, all the samples studied had green color.

The value of the parameter b^* show whether the color of the object studied is blue or yellow. If the value is negative, then the object studied is blue and if positive, its color is yellow [16]. It can be seen from the results shown in Table 3 that the highest value of b^* had the biscuits made from 30%E and 70%EF (23.99 ± 1.55) and the lowest value had the biscuits made from 100%EF (20.61 ± 0.06). the differences are very small. With respect of this parameter, the biscuits obviously had yellow color.

The parameter ΔE shows the relationship between the human perception of biscuits color and the total change of the color. As can be seen from Table 3, the values of this parameter decrease with the increase of the amount of EF in the biscuits.

The values determined, considered with respect to the definitions in Table 1, indicate that all type of biscuits can be classified in the group “medium perceptible differences” of biscuits color, even these produced from 100% einkorn, since it was assumed that their value of $\Delta E = 6.02$ exceeds the boundary value ($\Delta E = 3-6$) and this difference is within the range of the standard deviation.

Conclusion

It was concluded from the studies carried out that the increase of the amount of einkorn flakes added to einkorn flour results in slightly lower baking losses and volume of baked biscuits. The highest volume had the biscuits without einkorn flakes (100%E). substantial decrease of biscuits volume was observed even with the addition of the smallest quantity of einkorn flakes (30%) to the recipe. The baking losses are significantly smaller (by about 3,5%) for the biscuits manufactured from 100%EF compared to the other samples where the difference was only 1%.

All the samples of biscuits had colors in the green and yellow spectrum and the lightest ones were these produced from 100% einkorn flakes. The differences between the individual samples were insignificant.

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