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The quantification of quality and health benefits of bread fortified with sodium caseinate

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Abstract

A proper appreciation of the potential benefits or adverse effects associated with nutrients and other components of food, led to the possibility of designing foods with specific characteristics, able to influence body functions, beyond their basic function, that of insuring the need for food. The aim of this study was the proteic fortification of wheat flour with sodium caseinate and the analysis of the obtained results, quantitatively and qualitatively as well, respectively in ensuring the optimal equilibrium of essential amino acids, without which the protein contribution has only a reduced efficacy. Through wheat flour fortification with 10% sodium caseinate there was a good recovery of the deficit of two essential amino acids, lysine, whose content increased from 32.64%, according to the control sample, to 65.91% according to the fortified sample, and threonine, whose intake was improved from 77.25% to 90.70%. As for the sensory aspect, the fortified product has a slight color change and a much higher volume compared with the unfortified sample.

Keywords: proteic fortification, bread, sodium caseinate, bread quality, protein content, proteic value, essential amino acids, health benefits

1. Introduction

All Until recently nutrition has been concerned with identifying some deficiencies associated with diets that could lead to the installation of disease and avoid these deficiencies by providing an adequate intake of key nutritional factors. Impact of diet on the health status of the body is much greater than that of ensuring nutritional needs. It is clear that aspects of lifestyle, diet and physical activity play an important role in increasing the incidence of these diseases, and the success of measures to reduce them will depend on striking the balance between these factors. This led to the conclusion that diet can help maintain long-term health, ways until now unrecognized, which implies a new dimension to the appreciation of how food can positively influence health and well-being, beyond providing the necessary nutrients (Howlett, 2008).

The main challenge of the nutrition process is to design a balanced diet, ensuring adequate intake of nutrients to maintain the balance between energy intake, metabolism and physical activity (IFT, 2005).

Thus arises the need for a diet consisting of foods rich in nutrients with a high energy (food with high nutritional density), but consumer expectations and modern life style do not facilitate this challenge. Simultaneously, better assessment of the potential beneficial or adverse effects associated with nutrients and other components of food, led to the possibility of designing foods with specific characteristics, able to influence body functions beyond their basic function, that of insuring the need for food (Howlett, 2008).

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Functional foods are seen as a concept in which concern for providing nutrition and health of the body have taken on unprecedented importance, concerning the nutritional role of food in direct relationship with the health of the body (Wolfe, S., 2002).

Functional foods are generally considered as those foods which are intended to be consumed as part of the diet and that contain biologically active ingredients that have a potential for increased health and reduce risk of disease (Subirade, M., 2007).

To ensure the protein need of the population from unfavorable areas, different methods have been approached, one of them being the fortification of the bakery products, the main vector of fortification included in the population's daily nourishment. The wheat flour fortified with exogenous proteins aims at obtaining bakery products valuable in proteins, recommended to consumers, and especially to people who suffer from proteic malnutrition, increasing the proteic value of the flour and bread respectively, by correcting the content of essential amino acids, without generating a substantial deterioration of its technological features.

The proteic exogenous source used in this study to fortify the flour in order to obtain fortified bakery products was sodium caseinate, in concentrations of 3, 5, 10 and 15% respectively.

Proteins from dairy products are functional ingredients, with unique properties and are incorporated into many foods. Ingredients from the milk industry may be used to obtain bread, because of the nutritional benefits they generate: increasing content of calcium and protein intake efficiency and operational benefits including improved flavor, texture and length of storage. They may increase water absorption and may improve the manual processing of the dough (Cocup, R.O, et.al., 1987).

2. Materials and Method

The flour used in these experiments was white flour, type 650, obtained by means of grinding wheat of Triticum aestivum L species, in the mill of S.C. Boromir Prod Buzău. In order to standardize the content of α-amylase, the flour was ameliorated in the mill by adding 1g α-amylase/100 kg flour, with an amilolitical activity of 140000scp/g. In order to increase the extensibility of the dough, to decrease the unfavorable effect of the insoluble hemicelluloses on the continuity of the gluten motion and to increase the conservation period of bread freshness, 6g hemicellulase/100 kg flour have been added. For a better tolerance of the dough rising, 2g xilanase/100 kg flour has been added, and for the hardening of the gluten receipt 1g ascorbic acid/100 kg flour has been added. In order to improve the technological quality of the flour 8 g cystein (50%)/100 kg flour have been added.

Due to high content of milk protein, sodium caseinate confer enhanced functionality, providing good moisture retention and good structural characteristics and binding. It is low in lactose and therefore it doesn't affect the sweet taste of the finished product. On the other hand, lactose and whey powder are presented in this product in a rapport which removes the optimal formation of compounds type Maillard.

Table 1. Chemicals parameters of sodium caseinate

Component	U.M.	Sodium caseinate
Proteins	%	89.5
Fat	%	0.8
Ash	%	4.5
Moisture	%	5.0

Table 2. Essential amino acids content of sodium caseinate compared with FAO/OMS recommendations (g/100g protein)

Essential amino acids	**FAO/OMS recommendations**	**glutenic proteins**	**Sodium caseinate**
Phenylalanine + Tyrosine (Phe + Tyr)	6.00	7.70	10.6
Threonine (Tre)	4.00	2.40	4.3
Triptofan (Trp)	1.00	1.00	1.2
Leucine (Leu)	7.00	6.90	9.1
Isoleucine (Ile)	4.00	4.20	4.6
Valine (Val)	5.00	4.30	5.7
Lysine (Lys)	5.50	1.60	7.7
Methionine + Cystein (Met + Cys)	3.50	3.40	3.3

The fortified products were assessed by carrying samples through the indirect baking process (SR ISO 6820:2002 and SR 91-83). The purpose of these tests was to determine the influence of added protein on the sensory characteristics of the product, on volume, elasticity, porosity and acidity of it. On the other hand it sought to increase the proteic value of bread while increasing the concentration of added protein used, the proteins quality, in order to determine to what extent it can optimize the bread quality while increasing the protein content of it.

For a good comparative appreciation of the effects of the proteic supplements over the organoleptic characteristics of the bread, their sensorial evaluation was realized through scoring, using an evaluation scale of 20 points. The quality evaluation of the proteins consisted in the analysis, by liquid chromatography of high performance (RP-HPLC), of bread samples obtained from the fortification of wheat flour with sodium caseinate (Altmann, 1992). A Hewlett-Packard HP 1050 series system equipped with a programmable auto injector capable of performing the pre column derivation step was used.

Table 3: The variation of the protein content of the flour and bread, with the increase of the concentration of sodium caseinate

Protein content [%]									
Sample flour	Flour fortified with sodium caseinate				Unfortified bread	Bread fortified with sodium caseinate			
	3%	5%	10%	15%		3%	5%	10%	15%
12.35	14.60	16.02	19.36	22.41	10.20	11.37	13.71	17.38	20.25

3. Results and Discussion

It is known that one of the most effective ways to increase the biological value of protein in bread is to use proteic derivatives from dairy industry, which in addition to their contribution and what it brings in terms of their content of essential amino acids, may fortify bread with phosphorus and calcium. Using wheat flour fortification with sodium caseinate increased the protein content of bread, which can be explained by the high-protein content of this exogenous proteic source. Sodium caseinate supplements in proportions of 3, 5, 10 and 15 % respectively in the flour sample, determined an increase of the protein content of the flour, and of the bread respectively, at the same time with the increase of the concentration of the proteic supplement (table 3). Results of sensory evaluation of the quality of bread fortified with sodium caseinate are shown in Table 4. Bread fortified with 3% and 5% sodium caseinate, has not presented any reduction in volume compared to the unfortified bread, and the sensory evaluation of the quality obtained a maximum score. Bread fortified with 10% sodium caseinate has a higher volume than the unfortified bread and respectively, than products fortified with lower concentrations of added protein,

the only flaw being revealed due to the crumb with irregular pores and gaps. Bread fortified with 15% sodium caseinate is distorted and has a lower volume. Peel product presents a number of wrinkles, and the crumb is dense, non-elastic with large pores, uneven and thick walls, areas with dense layers of compact or more off color than the unfortified bread.

Control flour fortification with sodium caseinate increased the volume of bread compared to that of unfortified bread. The volume of bread obtained from flour fortified with 10% sodium caseinate was a maximum one, while fortifying at higher concentrations generated a significant decrease in the bread volume proportional to the increase of sodium caseinate (table no. 4). Flour fortification with 10% sodium caseinate generated products whose volume are within the limits of capacity, while flour fortifying over 10% has decreased volume of the bread below the specified standard of quality.

Such fortification of wheat flour with up to 5% sodium caseinate resulted in obtaining products whose volume is equal to the control sample, while flour fortification with 10% sodium caseinate has increased bread volume by 0.7% against control sample. Instead, flour fortified with 15% sodium caseinate determined a decrease of bread volume with 34.8% compared with the control sample. The increase of the bread volume, in case of maxim 10% sodium caseinate fortification can be explained by the lower influence of sodium caseinate on dough rheology which ensures the increase of the capacity of retaining gases.

The advantage of using this type of exogenous protein is that besides the substantial increase of the bread volume, the crumb elasticity of bread fortified with 10% sodium caseinate was not affected (table no. 4), while the values recorded in the limits specified by the quality standards. For products made from flour fortified with sodium caseinate at concentrations higher than 10%, there was registered a reduction in the crumb elasticity, while increasing the concentration of the added protein used, the values being below the limit specified by the quality standard. Fortification of wheat flour with up to 5% sodium caseinate ensures fortified products whose crumb elasticity remains constant compared to that of the control sample, while a fortification of 10% sodium caseinate increases crumb elasticity with 4.3 % than those of control sample. In contrast, fortification of wheat flour with 15% sodium caseinate leads to a reduction in the crumb elasticity with 29.8% compared with control sample.

Crumb porosity recorded values within the limits specified by the quality standard, regardless of the concentration of the fortification. Changes in this indicator were higher while increasing the concentration of added protein in case of fortifying the control flour at concentrations up to 10% sodium caseinate, because above this concentration crumb porosity of bread recorded a decreasing change, more significant as the concentration of added protein increased (table no. 4). Fortification of wheat flour with 3% sodium caseinate ensures that bread whose crumb porosity remains constant compared to control sample porosity, while fortification of wheat flour with 5% and 10% sodium caseinate leads to an improvement in crumb porosity with 1.2% and respectively, 3.5% of that of the control sample.

A wheat flour fortify with 15% sodium caseinate generates a porosity reduction of 4.7% compared with the control sample.

Bread acidity has recorded an increasing variation compared to the value recorded for the control sample, with increasing the concentration of the added protein used (table no. 4).

Table 4: The results of the organoleptic evaluation of bread fortified with sodium caseinate

Quality indices	UM	Control sample	Fortified bread with sodium caseinate			
			3%	5%	10%	15%
Bread note	points	19.5	20.0	20.0	19.5	14.5
Volume bread	$cm^3/100g$	408	408	408	411	266
Elasticity crumb	%	94	94	94	98	66
Porosity bread	%	85	85	86	88	81
Acidity bread	grade	1.0	1.15	1.25	1.5	1.6

Bread volume and decreased elasticity of the crumb and the modification of the crumb color at high proteic additions, limits the concentration of sodium caseinate used to wheat flour fortified at 10% compared to the flour quantity. Overcoming these technological limitations generates major changes in dough rheological properties, an increased resistance to stretching and of P/L ratio and respectively, a decrease of dough extensibility, which generates decreased restraint gas fermentation, a low bread volume and impairment of quality of the bread.

To assess the quality of the protein intake through fortification of wheat flour with sodium caseinate it was performed the RP-HPLC analysis of samples of breads and the results expressed in mg protein / g product and a percentage relative to the protein content of the product, are presented in Table 5. The largest increases in amino acids content in bakery products made from flour fortified with sodium caseinate were recorded by the lysine and methionine, while cystein and isoleucine had less significant increases. The remaining amino acids had average increases with increasing concentration of added protein used.

In order to analyze the effectiveness of the fortifications carried out with sodium caseinate, there was compared the essential amino acid content of fortified samples with essential amino acid content of protein type FAO (table 5).

Limited amino acid of unfortified sample, lysine and threonine respectively, remain limited to fortified products with sodium caseinate, but the deficit is reduced substantially.
Thus, the unfortified sample lysine intake, compared to FAO protein type, is only 32.64%, but the wheat flour fortify with sodium caseinate generated a product with a lysine covering 72.75 % of FAO protein. Since fortification with sodium caseinate may not, for technological reasons, overcome 10% protein, lysine content of such fortified products will cover in this case, only 65.91% of FAO recommended necessary.

Table 5. The amino acids content of fortified bread with sodium caseinate [mg/g protein], related to dry matter and covering degree of FAO combination

Essential amino acid	**Essential amino acids content of fortified bread [mg/g protein]**					**FAO protein content mg/g protein**	**The coverage proportion of the content of FAO protein**				
	control	**sc 3%**	**Sc 5%**	**sc 10%**	**sc 15%**		**control**	**sc 3%**	**sc 5%**	**sc 10%**	**sc 15%**
Thr	30.90	36.11	36.13	36.28	38.61	40	77.25	90.28	90.33	90.70	96.53
Tyr + Phe	92.43	92.59	92.87	93.75	93.82	60	154.05	154.32	154.78	156.25	156.37
Val	48.74	48.83	50.27	53.78	57.83	50	97.48	97.66	100.54	107.56	115.66
Ile	40.77	40.98	41.75	44.89	45.27	40	101.93	102.45	104.38	112.23	113.18
Leu	85.64	86.60	86.72	92.46	92.55	70	122.34	123.71	123.89	132.09	132.21
Lys	17.95	25.25	33.04	36.25	40.01	55	32.64	45.91	60.07	65.91	72.75
Cys + Met	38.92	39.91	40.05	40.09	40.11	35	111.20	114.03	114.43	114.54	114.60
Trp	11.10	11.11	11.27	11.35	11.39	10	111.00	111.10	112.70	113.50	113.90

Regarding the threonine deficit, this is substantially reduced by fortification with sodium caseinate. Thus, if the unfortified products cover 77.25% of the FAO recommendations, by wheat flour fortification with sodium caseinate products are obtained which ensure 96.53% of this type of amino acid compared with FAO protein. Even in a protein addition of 10% sodium caseinate (the maximum allowed technological limit) are obtained products that are covering 90.70% of threonine content of FAO protein.

Although unfortified products recorded a small deficit of valine (2.52% compared with FAO recommendations), it is fully restored in a wheat flour fortification of only 5% sodium caseinate (100.54%), for upper fortification to ensure a small surplus in this amino acid.

Thus, if wheat flour fortification by 10% sodium caseinate (the allowed technological limit) valine content is 107.56% compared to the FAO-type protein, at higher protein fortification this amino acid intake rises to 115.66 % compared with FAO recommended requirements.

The remaining essential amino acids have covered the requirements recommended by FAO, their proportion recording increasing variations with the increase of the added protein. The largest content was recorded by tyrosine, phenylalanine and leucine.

For a better assessment of protein quality of fortified products, there were calculated the chemical indices of limiting essential amino acids from bakery products fortified with sodium caseinate, and EAA, - Index of essential amino acids (Table 6).

Table 6. Essential amino acids indices and EAA-Index of bakery products fortified with sodium caseinate

Protein additions	EPV_{Lys}	EPV_{Tre}	$EPV_{Tyr+Phe}$	EPV_{Val}	EPV_{Ile}	EPV_{Leu}	$EPV_{Cys+Met}$	EPV_{Trp}	EAA-Index
martor	32,64	77,25	154,05	97,48	101,93	122,34	111,20	111,00	93,47
3%sc	45,91	90,28	154,32	97,66	102,45	123,71	114,03	111,10	100,04
5%sc	60,07	90,33	154,78	100,54	104,38	123,89	114,43	112,70	104,37
10%sc	65,91	90,70	156,25	107,56	112,23	132,09	114,54	113,50	108,61
15%sc	72,75	96,53	156,37	115,66	113,18	132,21	114,60	113,90	112,03

The wheat flour fortified products with sodium caseinate recorded variations of the chemical index of lysine ranging from 45.91%, corresponding to a concentration of 3% added protein and 72.75%, corresponding to a 15% protein addition. The maximum technological limit allowed for the fortification with sodium caseinate, which is about 10% exogenous protein addition, ensures that fortified products whose chemical index of lysine is 65.91%, are appropriate to body requirements in order to maintain the nitrogen balanced.

The results indicate an increase of all essential amino acids chemical indices with increasing the concentration of the added protein used.

4. Conclusions

It is clearly understood that the market is determined by taste, convenience, the possibility to prevent diseases and individualized nutrition.

The protein exogenous fortification of bakery products may be a solution to ensure the necessary intake of essential amino acids and thus prevent diseases caused by deficiency of these nutrients.

Bread fortified with sodium caseinate at concentrations up to 10% meets all quality indicators specified by standards. Bread volume and decreased elasticity of the crumb and the modification of crumb color high in additives, limit the concentration of sodium caseinates used to fortify at 10% compared to the flour quantity.

Overcoming technological limitations generates major changes in dough rheological properties, and increased dough resistance to stretching and the ratio P / L and decreased dough extensibility, which generates decreased restraint gas fermentation, low bread volume and impairment of quality of the finished product.10% wheat flour fortification with sodium caseinate can be considered a good solution both in terms of technological and nutritional point of view, providing a fortified product containing 17.38% protein and a high essential amino acids index, 108.61 respectively. This fortification option ensures the restoration of the major deficiency of essential amino acids, lysine and threonine respectively. From the sensory point of view, the fortified product with 10% sodium caseinate has a slight crumb color modification, a higher volume than the unfortified sample, but uneven crumb porosity. Taste and aroma of the fortified bread have not changed the quality.

Health concerns can not be questioned, which is why maintaining health becomes a new standard for food industry (producers of food products must have the intrinsic health of marketing - a strategy involving the least risk product).

Although there are several factors that ensure the success of a product, what is decisive for a food product is its taste and accessibility. In addition, a functional food should be marketed to meet the health needs of the organism, which should be well understood by consumers. Ultimately, the price is the one that influences the decision to purchase the product or not.

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