COMPARATIVE CHEMICAL ANALYSIS OF WHITE AND WHOLEWHEAT BREAD

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ABSTRACT: Bread is the basic food, being an important source of carbohydrates, vitamins and minerals. There are a variety of types of bread, depending on the type of flour used (wheat or related grains), preparation techniques, and additional ingredients. The main ingredients that form the basis of obtaining white bread are white wheat flour type 650, water, salt, yeast, sugar, oil, additives, and those that form the basis of obtaining whole wheat bread are whole wheat flour 100% or mixed with white flour, water, salt, yeast or natural mayo and optionally, seeds, bran, honey, vegetable oil. In order to highlight the nutritional difference between white bread and wholemeal bread, the paper presents a comparative study on the chemical composition of white bread (standard, sliced, packaged) and wholemeal bread, in terms of the natural chemical compounds resulting from the ingredients used in the preparation process, the chemical additives added, the chemicals formed during baking, as well as the comparison of the main characteristics.

KEY WORDS: bread, analysis, composition, white, wholewheat

1. INTRODUCTION

Bread is a daily staple, especially in Europe, which is one of the oldest and most important foods in human history. Regarding its history and culture, bread has played a crucial role in the development of human civilization, being the central element of some historical events and religious beliefs, an important cultural and spiritual symbol in Romania ("Our daily bread..." Our Father, the most famous prayer of all Christians).

Compositionally, bread is traditionally prepared from wheat flour or related cereals (rye, barley, oats, millet, buckwheat, corn, sorghum) or from mixtures of flour from cereals or cereals with legumes (potatoes, soybeans), water and yeast, to which various ingredients can be added, depending on the recipe and the type of bread. The nutritional importance lies in the fact that bread is an important source of carbohydrates, vitamins and minerals, the content depending on the type of flour from which it is prepared.

The preparation of bread is based on traditional or modern recipes, with the same stages: preparation of raw materials, preparation of leaven (on which the success of the bread depends), kneading the dough, fermentation of the dough, dividing the dough and forming the bread, leavening the dough, baking the dough, cooling the bread. Bread is the representative product of biologically leavened bakery products, obtained by baking fermented cereal dough (populations in some cultural areas use unfermented dough, from which they produce unleavened bread, for religious reasons).The quality, characteristics, appearance and taste of the bread differ depending on the technology applied (the collective oven in Transylvania is a valuable traditional element, with broad social values, the dough in southern Romania, made within a ritual rich in meanings), the flour (from mountain wheat, ground in a stone mill, promoted by multinationals or manufactured in superproductive mills, from which it comes out so hot that a large part of the enzymes are destroyed during grinding), water (from own source, deep well drilled in

the yard, city network) or if it is baked on the hearth of a certain oven or prepared by a certain baker.

From a commodity point of view, bread is a bakery product with many varieties, classified according to the following criteria: the basic raw material (flour - simple white, semi-white, black, dietary bread; with added potatoes; with rye flour), the complexity of the composition (pastry products, containing sugar, oil, malt extract and special pastry products, buns, rolls, croquettes, containing sugar, milk, oil, eggs, cheese), special destinations (assortments for consumers with special needs, achlorid (salt-free), low-gluten or gluten-free bread, with calcium, for diabetics, with eggshell, graham). The Romanian standard specifies the characteristics that white bread must meet (water - maximum 45 %; porosity - minimum 73 %; acidity - maximum 3,5 degrees; salt content - maximum 1,3 %), packaging, marking, storage and transport conditions (aseptic, bright, ventilated spaces, free of micro- and macro-pests, at a temperature of 10-20 degrees Celsius and relative air humidity 70 %), the shelf life varying for the different varieties (24-72 hours from the moment of baking).

There are a variety of types of bread, depending on the type of flour used, preparation techniques and additional ingredients, adapted to the region. The types of bread, divided by categories (according to the main ingredients, the type of flour or the method of preparation) and the characteristics of each one are shown in Figure 1 and Table 1.

Figure 1. Types and categories of bread

Table 1. Classification of bread types, divided by categories, characteristics and description of each type

classification	type of bread / category	characteristic additional content description
type of flour	white	from refined white flour, type 650 few fibers, neutral taste, soft
	wholemeal	from wholemeal flour, with the whole grain richer in fiber, B vitamins
	black	from rye flour or mixture with dense, slightly sour wheat flour
	maize	gluten-free, yellow, with a sandy texture
	rye	with a high fiber content, specific taste, slightly fermented
	oat	oat flour or mixture fluffier texture, beneficial for digestion
	no gluten	from rice flour, corn, chickpea, tapioca for gluten intolerants
additions and composition	with seeds	flax, sesame, sunflower
	with potatoes	mashed potatoes added softer texture
	with olives or onions	intense taste, specific to the mediterranean regions
	with butter or oil	softer, used in sandwiches
	with milk	fluffier texture, slightly sweet taste
	sweet	sugar, milk, eggs (cake, muffins)
origin and tradition	baguette	long, crispy on the outside (France)
	ciabatta	white, airy, crispy skin (Italy)
	focaccia	flat, with herbs, olive oil (Italy)
	pita	round, with air pocket (Greece, Middle East)
	naan	soft, tandoori baked loin (India)
	lepie / lipie	round, flat (Romania)
	tortilla	thin plate, made of corn or wheat (Mexico)
	roti / chapati	thin sticks, baked on the stove (India, Pakistan)
	cottage	traditional, baked on the hearth (Romania)
baking method	on the hearth	baked directly on the stone
	to the tray	baked in rectangular shapes
	to steam	mantou (China), soft texture
	roasted	sliced, baked

For consumption by healthy adults, the best bread is:

- whole and fresh, but not warm (old bread loses its pleasant taste, the core is compact, hard, inelastic, crumbly, cracked; aging of bread can be delayed if liquid yeasts and hops are used, if part of the flour is scalded or if milk, fat or malt extract is added to the dough)
- fried (for breakfast it helps digestion)
- true black (without the addition of dye; in the section it shows a network of darker points, which are fragments of bran; the colored one has a uniform color in the section, without specific points, it is cheaper and less crumbly)

2. CLASSIFICATION OF CHEMICAL SUBSTANCES IN BREAD

Chemical substances in bread are classified as follows:

1. natural (from ingredients: flour, water, salt and yeast)

a. carbohydrates (carbohydrates) (Figure 2)

- starch (main polysaccharide from flour)
- simple sugars (glucose, maltose, which appear during fermentation)

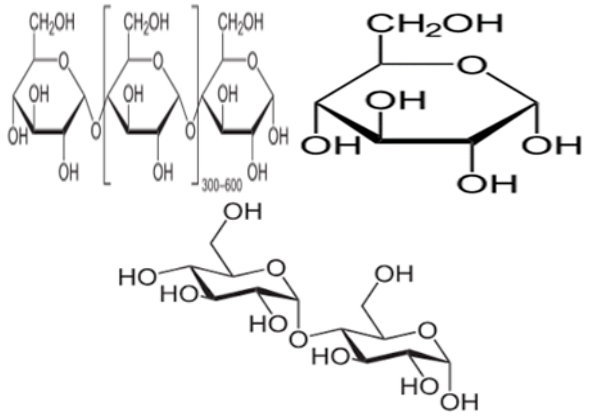

Figure 2. Chemical formula starch, glucose and maltose

b. proteins

- gluten (complex of gliadin and glutenin proteins, which give dough elasticity) (Figure 3)
- amino acids (in small amounts)

Figure 3. Complex of gliadin and glutenin proteins

c. minerals (Ca, Fe, Mg, K – especially in wholemeal bread)
d. vitamins (in small amounts, B1 thiamin, B2 riboflavin, B3 niacin, B9 folic acid)
e. dietary fibers (cellulose, hemicellulose) (Figure 4)

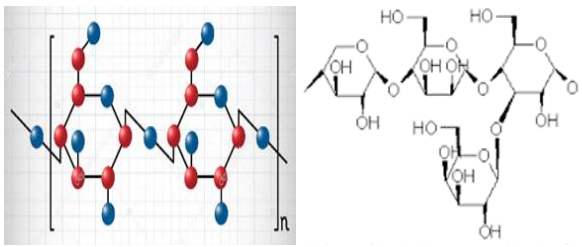

Figure 4. Chemical formula cellulose and hemicellulose

2. added (in industrially processed bread, depending on the recipe and the type of bread - white, sliced, with a long shelf life)
a. food additives (Es, enhancers) (Figure 5 and Figure 6)

- E300 (ascorbic acid) - antioxidant, improves texture
- E322 (lecithin) – emulsifier
- E282 (calcium propionate) - preservative against mould
- E471 (mono- and diglycerides of fatty acids) – emulsifier
- E920 (L-cysteine) - bakery improver

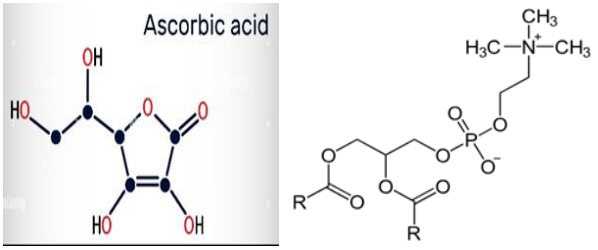

Figure 5. Chemical formula E 300 and E 322

Figure 6. E282 - calcium propionate

b. other additions

- salt
- sugar (for taste and fermentation)
- vegetable oil or fat
- artificial or natural flavors
- acidity correctors (citric acid)
- preservatives

3. *formed during baking* (during baking, at 180–250°C, the following chemical reactions take place:
a. Maillard products (Figure 7)

- reaction between amino acids and sugars → brown crust, aromas
- some resulting substances can have antioxidant potential, but also negative effects if they are in excess

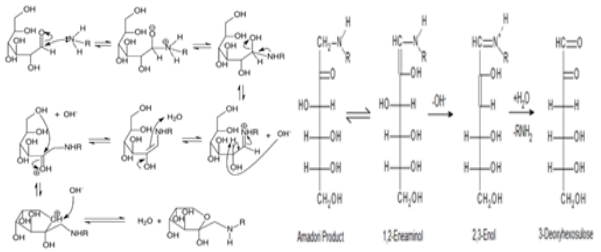

Figure 7. Maillard reaction

b. acrylamide (Figure 8)

- forms in the fried or burnt crust
- substance with carcinogenic potential, if frequently consumed in large quantities

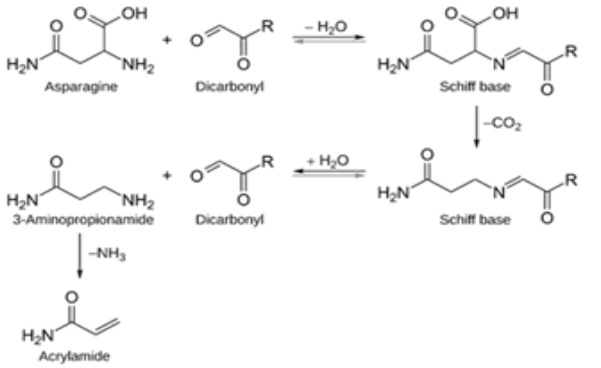

Figure 8. Formation of acrylamide

3. COMPARATIVE STUDY ON THE CHEMICAL ANALYSIS OF WHITE BREAD AND WHOLEMEAL BREAD

The main ingredients that form the basis of white bread are: white wheat flour type 650, water, salt, yeast, sugar, oil, additives.

The main ingredients that form the basis of whole grain bread are: whole wheat flour 100% or mixed with white flour, water, salt, yeast or natural mayo and optionally seeds, bran, honey, vegetable oil (Figure 9).

Figure 9. White bread and whole wheat bread

To carry out the comparative study on the chemical composition of white bread (standard, sliced, packaged) and wholemeal bread, the natural chemical compounds resulting from the ingredients used in the preparation process (Table 2), the added chemical additives (Table 3), the chemical substances formed during baking (Table 4), as well as the comparison of the main characteristics (Table 5) are shown.

Table 2. Natural chemical compounds in ingredients

type of bread	chemical substance	examples	role in the human body
white	carbohydrates	starch, maltose, glucose	main source of energy
	protein	gluten (gliadin, glutenin)	support the muscle structure
	mineral	Ca, Mg Fe (cellulose, hemicellulose)	cellular and bone functions digestion colon health
	vitamins	complex B (B1, B2, B3, B9)	metabolism nervous system
wholemeal	carbohydrates	starch, maltose	main source of energy
	protein	gluten, essential amino acids	tissue support
	mineral	Fe, Mg, Zn, P	immunity bone and muscle health
	vitamins	B1, B2, B3, B6, B9 (folic acid), E	metabolism nervous system
	dietary fiber	bran (cellulose, lignin)	healthy digestion blood sugar control

Table 3. Chemical additives added

type of bread	Code E	chemical substance	function or role in food
white	E300	ascorbic acid, vitamin C	antioxidant, strengthens the dough
	E282	calcium propionate	preservative (against mold)
	E471	mono and diglycerides	emulsifiers (texture)
	E322	lecithin	natural emulsifier
	E920	L-cysteine	baking improver
wholemeal	E300	ascorbic acid	antioxidant, helps fermentation
	E282	calcium propionate	preservative, anti-mold
	E471	emulsifiers	texture, stabilizes the dough

Table 4. Chemicals formed during baking

type of bread	chemical substance	mode of formation / reaction	effect
white	Maillard compounds	reaction between proteins and sugars under heat	flavor, color, crust
	acrylamide	forms at high temperatures (>180°C)	potentially carcinogenic
wholemeal	Maillard compounds	reaction proteins + sugars	flavor, crust
	acrylamide	when the crust burns (high temperatures)	potentially carcinogenic (in excess)

Table 5. Comparison of basic characteristics of white bread and wholemeal bread

characteristic	white bread	wholemeal bread
fiber	low	high
vitamins and minerals	less	more
taste	neutral	cereal flavor
texture	fluffy	thick
glycemic index	bigger	smaller

CONCLUSIONS

1. Bread is an important source of carbohydrates, the fiber and vitamin content being lower in white bread compared to wholemeal bread.
2. White bread is a processed food with high energy value, but with low nutritional content compared to wholemeal bread (it contains less vitamins and mineral salts, because white flour does not contain the outer part of the cereal grain, where most of the vitamins and mineral salts are located). The chemical analysis highlights the presence of beneficial natural substances, but also the risk of synthetic compounds or those formed at high temperatures.
3. Wholemeal bread is healthy, rich in fiber (combats constipation, maintains satiety), vitamins and minerals (being recommended in balanced diets, weight control, blood sugar and cholesterol control, digestion and prevention of cardiovascular diseases).
4. Artisanal or eco wholemeal bread contains at least 90-100% wholemeal flour and does not contain additives.
5. Industrial bread contains additives to extend the shelf life and fewer valuable elements than bread prepared from wholemeal flour obtained in a mill (where the grain grains are not degerminated, because the germs ground into the flour contain the highest concentration of valuable vital elements, but their presence in the flour reduces its shelf life)

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