ORGANOLEPTIC ANALYSIS AND PHYSICOCHEMICAL PROPERTIES OF SIX TYPES OF FLOUR ON THE ROMANIAN MARKET

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RESEARCH ARTICLE

Abstract

In this paper, six types of flour on the Romanian market were analyzed (3 white and 3 black). The organoleptic characteristics (color, smell, taste) and physicochemical properties of these types of flour were analyzed.

It was observed that the six types of flour have colors, taste and smell that fall within the limits provided by the legislation in force. When determining the hydration capacity of wheat flour, it was found that it is 59.22 – 59.68 % (white flour) and 57.88 – 58.54 % (black flour). When determining wet gluten, it had values between 28.33%-28.61%, and the humidity varies between 14.32-14.42 % (white flour) and between 14.39 – 14.46 % (black flour). The ash content of the analyzed flour varies between 0.33-0.42 % (white flour) and between 0.92-0.99 % (black flour). The acidity of flour, it varies between 1.93 - 2.13 degrees acidity (white flour) and 3.53 - 3.73 degrees acidity (black flour). All the values obtained fall within the limits provided by the legislation in force.

Keywords: flour, gluten content, ash, flour acidity
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INTRODUCTION

Wheat (*Triticum aestivum* L.) is a primordial cereal globally, with a diverse range of culinary applications including bread, pasta, biscuits (Martín-Esparza & González-Martínez) In addition to serving as a substantial supplier of calories and various nutrients, wheat is considered nutritionally inadequate due to the deficiency of essential amino acids such as lysine and threonine in its cereal proteins, thus it has a high carbohydrate content (starch 63.07%, sugar 4.32% and cellulose 2.76%), but a low protein content (16.06%) (Kumar et al., 2011) The ash content of wheat is about 2.18%, it comprises trace elements including iron (33 ppm), copper (4.50 ppm), zinc (25.8 ppm) and macroelements such as calcium (437 ppm) and magnesium (1100 ppm) (Ciudad-Mulero et al., 2021) In addition, wheat is a source of vitamins and enzymes (α-amylase, β-amylase, proteases), and the distribution of minerals is primarily concentrated in the husk and germ (Bodor et al., 2024; Tejera et al., 2013) Flour, a fundamental foundation in global nutrition, is an emblem of culinary versatility, offering an extensive range of textures, flavors, and nutritional profiles (Butt et al., 2011) The sheer diversity of flours derived from different grains and sources presents opportunities for exploration, both in terms of their unique characteristics and the sophisticated methodologies used to determine them (Navarro et al., 2020)

In the field of nutrition, understanding the nuances of different flours is paramount. At the heart of this nutritional sequence is flour – a fundamental raw product derived through the complicated process of grinding grains (Dhingra

& Jood, 2002) The resulting flour, composed predominantly of endosperm cells, serves as a pivot for creating a diverse range of culinary delights (Abdelghafor et al., 2011) Bread consumption in industrialized countries contributes significantly to meeting about half of the daily carbohydrate requirement, about a third of the protein requirement, and between 50% and 60% of the recommended daily intake of vitamin B.

As key ingredients in an extensive range of food products, flours contribute not only to taste and texture, but also to a significant impact on the nutritional quality of finished products (Ndife et al., 2011) Among the primary grains used in the production of these staples, wheat and rye appear as staple ingredients in the bread-making industry. From wheat flour, a cornerstone in traditional breadmaking, to gluten-free alternatives such as rice, barley, and oat flour, each variant has a distinct set of attributes that influence its usefulness in culinary applications (Arp et al., 2017) White flours, famous for their versatility, are characterized by a low ash content, usually limited to 0.55.

Upon the addition of water, wheat flour turns into a cohesive viscoelastic dough, with gluten being the key component responsible for providing the dough's plasticity and stability (Guo et al., 2021; Schopf et al., 2021) The resulting gluten, which can be extracted by washing the dough components, plays a crucial role in determining the rheological properties of the dough. This includes cohesive and viscoelastic flow properties, which are essential during leavening (Morel et al., 2020)

This article analyzes the complex parameters associated with flour, such as color, taste, smell, presence of mineral impurities, ash content, wet gluten, moisture percentage, acidity.

MATERIAL AND METHOD

1. Materials

In this study, six types of flour that were purchased from supermarkets in Romania were used, of which three contain white flour and three black flours. The three types of white flour, of different origin and three types of black flour, purchased from supermarkets in Romania were rated as A1, A2 and A3, respectively N1, N2 and N3.

The reagents used: chloroform, distilled water, NaCl 2% solution, sodium hydroxide 0.1N, phenolphthalein 1%.

Equipment used: analytical balance Kern ABT 220-5DNM (Kern and Sohn GmbH, Balingen, Germany), optical microscopy OPTIKA B 380 (Italy).

2. Method

2.1.Determination of the organoleptic characteristics of flour

The color was determined by two methods: the Pekar method and the photocolorimetric method. We analyzed the six types of flour under a microscope.

To determine the odor, mix 5 g of flour with 25 mL distilled water heated to a temperature of 60-65oC for 2-3 minutes, then cover with a watch bottle, leaving at room temperature for 5 minutes. After removing the watch glass, watch for the smell of the suspension (ASRO, 1996).

To determine the taste, 1 g of the flour sample is chewed in the mouth, assessing the taste and the possible presence of mineral impurities (earth, sand, etc.), through the characteristic grinding that they produce when chewing. The flour should have a sweet, pleasant taste. Foreign tastes are due to improper storage or infestation of flour. Adulterated flour, due to rancid fats, has a bitter taste.

The mineral impurities in the flour sample are separated on the basis of the difference in density, using chloroform (d = 1.48) as the separating agent. For this, a small amount of flour is taken from the flour sample with a spatula, from different places, totaling about 1 g, which is introduced with the help of a funnel into a test tube with 10 mL chlorophome. The test tube is closed with a rubber stopper, shaken, then placed upright on a stand, taking care that no sample particles remain on the walls of the test tube. The test tube rotates a few times around its axis, after which it is left to rest for 30 minutes. The presence of any mineral impurities that are deposited on the bottom of the test tube is visually examined (ASRO, 1996).

2.2.Determination of the physicochemical properties of flour

2.2.1. Determination of the hydration capacity of wheat flour

The hydration capacity of the flour is carried out according to STAS 90-88 which replaces STAS 90-77. The hydration capacity of flour is an important property, which determines the yield of flour in the dough. The principle of the method consists in determining the amount of flour that corresponds to a known amount of water, necessary for the formation of a dough of normal consistency, under established conditions.

Fill a porcelain capsule with flour, level the surface of the flour with the help of a glass rod, make a recess by pressing with a pestle. Measure 10 mL of distilled water with a temperature of 18-20°C with a pipette and introduce them into the recess formed in the flour. Mix the water and flour with the help of a spatula, then with the help of your hand, knead, for homogenization. The dough obtained is weighed. The measurements were made in triplicate. The technological process is shown in Figure 1.

Figure 1. **The technological process of the hydration capacity of wheat flour**

2.2.2. Determination of wet gluten in flour

The method consists of transforming the flour into dough, washing the dough with a 2% NaCl solution (in order to separate the starch from the dough), followed by weighing the wet gluten and calculating the percentage of wet gluten in the sample.

For this determination, the dough sample was prepared, 25 g of flour was weighed, then it was placed in a mortar, 12.5 mL of 2% NaCl solution was added, and then the dough was kneaded by hand for 5 minutes. The dough obtained was washed with 2% NaCl on a gauze sieve for 30 minutes, dried with the help of the palms until it became sticky, the wet gluten was weighed on the analytical balance, and then the percentage of wet gluten was weighed.

2.2.3. Determination of flour moisture

Flour moisture is determined by the loss of flour mass by heating to 130 ± 2°C (Standardization, 1988) For the preparation of the sample it was necessary to weigh 5 g of flour, then to dry it in the oven for one hour at 130°C, then to cool it in the excicator for 30-60 minutes, and then to scale the ampoule with the sample obtained.

2.2.4. Determination of ash content in flour

Depending on the degree of extraction, the amount of ash in the flour also varies. In a flour with a high degree of extraction, the amount of ash is higher due to the higher level of mineral substances extracted from the wheat grain.

The determination of ash in flour is carried out using the dry method, which is the easiest and most inexpensive. It is based on the incineration of the flour sample until total combustion (ASRO, 1996) The preparation of the dough sample for analysis consisted of: weighing 25 g of flour, placing the sample in a calcination oven at 500°C, 24 hours per cube, subjecting it to cooling in an excicator for 60 minutes and mounting the ampoule with ash.

2.2.5. Determination of flour acidity

Acidity is expressed in degrees of acidity, which is the number of milliliters of NaOH 1N required to neutralize the acidity in 100 g of flour.

Reagents used in the determination of flour acidity

Sodium hydroxide, 0.1N concentration solution;

Phenolphthalein, 1% concentration alcohol solution.

Weigh 5 g of flour which is then homogenized with 50 mL of distilled water and stirred for a few minutes. Leave to rest for 10 minutes and then titrate with sodium hydroxide in the presence of phenolphthalein, until faintly pink in color.

RESULTS AND DISCUSSIONS

3. Determination of organoleptic characteristics

To determine the color, it was observed that the three types of white flour had a white or yellowish-white color, with a slightly gray tint. In the three types of black flour, the color observed was light gray, with a slight yellowish-white tinge.

From the State Standards, imposed by the Romanian Institute for Standardization, SR 877/1996 which replaces STAS 813-60, as far as bakery flour is concerned, the color of white flour must be white or yellowish-white, and it can also have a faint gray tint, and for black flour, the color can be gray, with a yellowish-white tint given by the existence of bran particles. From the analysis of the color for the six types of flour, it can be concluded that they fall within the limits provided by the legislation in force.

At the smell analysis, we found that the six types of flour have a pleasant, flour-like smell, with no musty, dark or other unpleasant smell.

The analysis of the taste of the six types of flour showed that they have a normal taste, a little sweet, neither bitter nor sour without grinding when chewing, which can be given by mineral impurities such as particles of earth, sand, etc.

4. Determination of the physicochemical properties of flour

4.1. Determination of the hydration capacity of wheat flour

$$\text{Hydration Capacity (\%)} = \frac{m_1}{m-m_1}\ x\ 100 \quad (1)$$

where: m – mass of the dough ball, in g; m1 – the amount of water used, in mL.

To determine the hydration capacity, the analyzes were performed in triplicate, and the average results were noted as a number ± SD (standard deviation). The results obtained are shown in Table 1.

Table 1.

The hydration capacity of the six flour samples taken in the process

Sample	Dough Weight, m (g)	Amount of water used, m_1 (mL)	Hydration capacity (%)	Average hydration capacity ± SD, %
A1	26.96	10	58.98	59.22 ± 0.43
	29.63	11	59.03	
	26.76	10	59.65	
A2	29.45	11	59.61	59.42 ± 0.22
	32.18	12	59.45	
	26.89	10	59.20	
A3	26.74	10	59.75	59.68 ± 0.07
	26.75	10	59.69	
	29.46	11	59.60	
N1	30.05	11	57.75	57.88 ± 0.13
	32.69	12	58.01	
	27.28	10	57.88	
N2	32.77	12	57.78	58.12 ± 0.48
	29.97	11	57.98	
	29.77	11	58.60	
N3	27.18	10	58.21	58.54 ± 0.33
	27.06	10	58.62	
	29.71	11	58.79	

From the State Standards, imposed by the Romanian Institute for Standardization, SR 877/1996 which replaces STAS 813-60, as far as bakery flour is concerned, the hydration capacity, %, is established for white flour, as well as for black flour between 58 - 60%, for a very good flour. From the data obtained, it can be seen that for white flour the hydration capacity varies between 59.22 – 59.68%, and for black flour between 57.88 – 58.54%, which shows that one of the black flours is a good flour (N1), and the others are very good (N2, N3). The analysis of the data obtained shows that the six types of flour fall within the limits provided by the legislation in force.

4.2. Determination of wet gluten in flour

To calculate the percentage of wet gluten we used the following formula:

$$\text{mg.u. (\%)} = \frac{m_{g.u.}}{m_p}\ x\ 100 \quad (2)$$

where: % g.u. – the percentage of wet gluten in the sample taken in the work. expressed in percentages; sqm = the mass of the flour sample taken in the work. expressed in grams; mg.u. = the mass of wet gluten determined in the sample of flour taken in work. expressed in grams (ASRO, 1996)

The results obtained in determining the percentage of wet gluten are represented in Table 2.

Table 2.

Determination of wet gluten percentage

Sample	The flour sample mass taken in work, m_p (g)	Wet gluten mass, mg.u. (g)	Wet gluten content, (%)	Mean wet gluten percentage ± SD, (%)
A1	25.32	7.19	28.38	28.33 ± 0.05
	25.28	7.17	28.35	
	25.19	7.12	28.27	
A2	24.97	7.05	28.22	28.29 ± 0.12
	25.21	7.12	28.24	
	25.05	7.12	28.41	
A3	25.12	7.20	28.67	28.61 ± 0.19
	25.08	7.12	28.37	
	25.11	7.23	28.80	
N1	25.16	7.21	28.67	28.59 ± 0.21
	25.08	7.14	28.47	
	25.24	7.22	28.62	
N2	25.05	7.16	28.57	28.37 ± 0.20
	25.10	7.11	28.31	
	25.21	7.12	28.23	
N3	24.98	7.10	28.41	28.61 ± 0.20
	24.89	7.14	28.69	
	25.22	7.25	28.73	

For the determination of wet gluten, the analyzes were performed in triplicate, and the average results were noted as a number ± SD.

According to the standards in force (SR 877/1996), the minimum wet gluten content of flours must be: 26% for type 480 and 650 flours, 27% for type 550 flours and 28% for type 000 flours.

4.3. Determination of flour moisture

The calculation formula for flour moisture is expressed in percentages and is as follows:

$$\text{Humidity (\%)} = \frac{m_1 - m_2}{m_1 - m_0} \; x\ 100 \quad (3)$$

where: m1 – the mass of the ampoule with the sample of flour taken in the process, before drying, expressed in grams; m2 – the mass of the ampoule with the sample of flour taken in work, after drying, expressed in grams; m0 – the mass of the empty vial, expressed in grams.

The results obtained in the analysis of the six types of flour are shown in Table 3. The determinations were made in triplicate, and the results of the average humidity were written as a number ± DS.

Table 3.

Flour sample moisture

Sample	Initial mass of the vial and flour sample, m_1 (g)	Mass of the dried flour sample and vial, m_2 (g)	Empty vial mass, m_0 (g)	Sample moisture content, (%)	Mean moisture content ± SD, (%)
A1	29.68	28.93	24.52	14.53	14.42±0.09
	30.02	29.23		14.36	
	28.86	28.07		14.36	
A2	30.11	29.39	25.10	14.37	14.32±0.09
	30.23	29.50		14.23	
	29.97	29.27		14.37	
A3	31.12	30.22	24.84	14.33	14.39±0.29
	30.56	29.72		14.68	
	30.84	29.99		14.17	
N1	30.55	29.79	25.23	14.28	14.46±0.37
	31.12	30.28		14.26	
	30.42	29.65		14.83	
N2	30.98	30.08	24.88	14.75	14.39±0.36
	30.88	30.02		14.33	
	29.78	29.09		14.08	
N3	30.65	29.85	25.15	14.54	14.41±0.13
	30.05	29.35		14.28	
	30.70	29.90		14.41	

From the State Standards, imposed by the Romanian Institute for Standardization, SR 877/1996 which replaces STAS 813-60, as far as bakery flour is concerned, the flour moisture percentage is set at a maximum of 14.5% for both white and black flour.

From the data obtained, it can be seen that for white flour the humidity varies between 14.32-14.42%, and for black flour between 14.39-14.46%, so the six types of flour analyzed fall within the limits provided by the legislation in force.

4.4. Determination of ash content in flour

The ash content of flour (%) can be calculated using the relation:

$$\% \text{ ash} = \frac{m_{ash}}{m_{sample}} \times 100 \quad (4)$$

where: ash – the mass of ash obtained after incineration, representing the difference between the mass of the crucible after incineration and the mass of the crucible initially weighed, expressed in g (ASRO, 1996).

The results obtained in this determination for all types of flour analysed are set out in Table 4. For each flour sample, three determinations were performed, and the average ash percentage values are denoted as the mean ± standard deviation (SD).

Table 4.

Ash content percentages for the six flours

Sample	Weight of the flour sample m_{sample} (g)	Mass of ash obtained after Incineration m_{ash} (g)	Ash content of flour (%)	Average ash content ±SD, (%)
A1	24.56	0.10	0.41	0.41±0.03
	25.31	0.10	0.39	
	24.87	0.11	0.44	
A2	25.01	0.09	0.36	0.42±0.06
	25.41	0.11	0.43	
	25.37	0.12	0.47	
A3	24.88	0.09	0.36	0.33±0.07
	25.42	0.07	0.27	
	25.26	0.09	0.36	
N1	25.08	0.22	0.88	0.99±0.12
	25.24	0.28	1.11	
	25.13	0.25	0.99	
N2	24.86	0.24	0.96	0.94±0.03
	24.98	0.24	0.96	
	25.22	0.23	0.91	
N3	24.89	0.26	1.04	0.92±0.12
	25.11	0.20	0.80	
	25.08	0.23	0.92	

According to the State Standards imposed by the Romanian Standardization Institute (ASRO) regarding flour for bread-making, the ash content percentage, reported on a dry matter basis, is established for White Flour at a maximum of 0.65%, and for Dark Flour (Black Flour) at values ranging between 0.91% and 1.40% (ASRO, 1996; Bordei, 2000; Bordei et al., 2007; Drăgoi et al., 2018; Modoran, 2007; Niculescu, 2000; Standardization, 1988).

The obtained data show that the ash content for the white flour ranges between 0.33% and 0.42%, and for the dark flour between 0.92% and 0.99%. This demonstrates that all six types of flour comply with the limits stipulated by the current legislation.

4.5. Flour acidity determination

Flour acidity calculation:

$$\text{Degrees of acidity } \% = \frac{V \, x \, F \, x \, 100}{10 \, x \, 5} \quad (5)$$

where: V is the volume of NaOH 0.1 N used for titration, in mL; F is the factor of the NaOH 0.1 N solution (the sodium hydroxide solution factor is 1); 5 is the mass of flour taken for the analysis (working mass); and 10 is the conversion factor for the NaOH solution normality, from 0.1 N to 1 N. (ASRO, 1996).

The results obtained for the acidity determination of the six types of flour are presented in Table 5. Determinations were carried out in triplicate, and the average acidity results are denoted as the mean ± SD.

Table 5.

Acidity of the six analyzed flours

Sample	Volume of NaOH for titration (mL)	Acidity of flour (Acidity Degrees)	Mean flour acidity ±SD (Acidity Degrees)
A1	1.1	2.2	2.13 ± 0.13
	1.0	2.0	
	1.1	2.2	
A2	1.2	2.4	2.2 ± 0.2
	1.0	2.0	
	1.1	2.2	
A3	0.9	1.8	1.93 ± 0.13
	1.0	2.0	
	1.0	2.0	
N1	1.8	3.6	3.66 ± 0.33
	1.7	3.4	
	2.0	4.0	
N2	1.9	3.8	3.73 ± 0.13
	1.8	3.6	
	1.9	3.8	
N3	1.8	3.6	3.53 ± 0.13
	1.8	3.6	
	1.7	3.4	

State Standards (SR 877/1996) from the Romanian Standardization Institute set the maximum acidity for baking flour at 2.8 degrees for white flour and 4.0 degrees for dark flour. The results show that the white flour acidity ranges from 1.93–2.13 degrees and the dark flour acidity ranges from 3.53–3.73 degrees, confirming that all six flour types fall within the legal limits.

Conclusions

The study presents an analysis of six types of flour from the Romanian market—three white flours and three dark flours—regarding both the flour's organoleptic characteristics (color, smell, taste) and its physico-chemical properties.

It was observed that the three types of white flour have a white or yellowish-white color with a slightly grey tint, while the three types of dark flour have a light grey color with a slight yellowish-white hue. These colors fall within the limits stipulated by the current legislation. The smell analysis confirmed that all analyzed flours have a pleasant odor, specific to flour, with no signs of mold, staleness, or other unpleasant smells. The taste of all six flour types is normal, slightly sweet, neither bitter nor sour, with no grit upon chewing.

The determination of the water absorption capacity of wheat flour ranges between 59.22%–59.68% for white flour and 57.88%–58.54% for dark flour. The wet gluten determination in the analyzed flour shows that all six flour types comply with the current standards (28.33%–28.61%). For flour moisture determination, it can be observed that the moisture content ranges between 14.32%–14.42% (white flour) and 14.39%–14.46% (dark flour). Regarding the flour ash content, it ranges between 0.33%–0.42% (white flour) and 0.92%–0.99% (dark flour). The determination of flour acidity shows it varies between 1.93–2.13 degrees of acidity (white flour) and 3.53–3.73 degrees of acidity (dark flour). All values obtained fall within the limits stipulated by the current legislation.

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