Evaluation of Physico-Chemical and Microbiological Parameters of the Types of Wheat Flour Produced in Milling Company

Afërdita Shtëmbari

***Abstract* — Wheat flour is one of the most used ingredients in bakery products, based on its nutritional and technological properties. Also in recent years, with the increase in the variety of dough products, there has also been an increase in the types of wheat flour in a way that suits the needs of the market. This study aims to analyze the physico-chemical and microbiological characteristics of some types of wheat flour produced by a milling company, which are used for different purposes, such as: white flour, brown flour, whole meal flour, etc. In total, 6 wheat flour samples of different types were analyzed for: moisture, ash, gluten, acidity, water activity and total microbiological load. The results showed that the moisture content is below 14.5 % for all samples. The range of ash content varies from 0.46-1.29 % and is different based on the type of flour, because it represents the total amount of minerals present in wheat flour. Acidity is the most used parameter to determine storage conditions and all samples had a low value of 0.09-0.21 %. The wet gluten content of the flour samples varies between the range of 27.3-34.4 %, the highest value of gluten was detected in brown flour. From the microbiological analyzes carried out, we see that the wheat flour samples analyzed result in a low microbial load. Based on the results of the analyzed samples, all types of wheat flour produced by this company have good quality in terms of the analyzed parameters. Usually, the quality of the final product depends on the quality of the raw ingredients. So, the study of the quality of wheat flour in terms of physico-chemical and microbiological parameters also means a higher quality and safety of bakery products.**

***Keywords* — Microbiological, Physico-Chemical, Quality, Wheat Flour.**

I. Introduction

Wheat (*Triticum aestivum*) is one of the most cultivated and consumed cereals in the world [1]. Cereal processing is an essential requirement to transform cereals into attractive and palatable bakery products. Those products are consumed throughout the world in their different varieties [2].

Wheat is considered a good source of protein, minerals, B-group vitamins, and dietary fiber although the environmental conditions can affect nutritional composition of wheat grains with its essential coating of bran, vitamins, and minerals; it is an excellent health-building food. Wheat flour is used to prepare bread, produce biscuits, confectionary products, noodles and vital wheat gluten or seitan [3]. In general, the quality of the flour is attributed to its moisture, gluten, lipid, acidity, mineral, and protein contents. These properties reflect the effect of the processing and can be used to evaluate the technological or nutritional quality of the product [4]. These parameters of flour, which depend on the wheat variety, the year and the conditions of harvest, and the milling technology are important for the use of flour in bakery and the quality of the final products [5].

In terms of the parts of the grain (the grass fruit) used in flour—the endosperm or protein/starchy part, the germ or protein/fat/vitamin-rich part, and the bran or fiber part—there are three general types of flour. White flour is made from endosperm only. Brown flour includes some of the grain's germ and bran, while whole grain or whole meal flour is made from the entire grain, including the bran, endosperm, and germ [6].

The type of flour, defined because of the ash content, only guarantees the production of white or darker crumb bread. In the USA and United Kingdom, no numbered standardized flour types are defined, and the ash content is only rarely given in the flour label by the manufacturers. However, the legal required standard nutrition label of flours indicates the protein content and its advisable use: multipurpose, pastry, cakes, biscuits, and bread [7].

Thus, due to the importance of the type of flour, the wide range of use of different varieties of wheat flour and the change of its physico-chemical characteristics depending on several factors. Our study focused on the evaluation of physico-chemical and microbiological quality parameters of several types of wheat flour samples produced in a milling company.

II. Material and Method

A. Sample Collection

This study focused on the physico-chemical and microbiological analysis of the types of wheat flour produced by a milling company in Saranda. This company produces several types of wheat flour depending on market requirements, depending on the use. All wheat flour produced is only for bakeries, pie and pizzeria companies, not directly for customers.

6 wheat flour samples (such as: white, brown, pie, pizza, semi-integral and integral flour) were investigated to determine some physical and chemical properties such as moisture, ash, acidity, water activity and gluten. Also, the microbiological load was analyzed. All samples were different types of wheat flour, for different uses.

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B. Determination of Physico-Chemical Parameters

1) Determination of moisture

Moisture content was determined using official methods [8]. In this method, above 3 g of wheat flour is weighed and placed in a moisture pan, and then the sample is heated in an air oven at 105°C for 3 hours. Then the sample is cooled and weighed. The moisture content was then calculated using (1).

$$M_c = \frac{a-b}{a} \times 100 \quad (1)$$

where M_c = moisture content (%); a = initial weight of sample (g); b = dry weight of sample (g).

2) Determination of ash

The total ash was determined - a sample of 5 grams of flour is weighed and placed in a crucible. The sample is heated over low Bunsen flame with lid half covered. When fumes are no longer produced, place the crucible heated at 550°C in an ash furnace until its weight doesn't change. The residue is cooled to room temperature and then weighed as described in AOAC methods [9]. The ash content was further calculated using (2).

$$A_{sh}(\%) = \frac{weight\ of\ ash}{weight\ of\ sample} \times 100 \quad (2)$$

3) Determination of alcoholic acidity

Total acidity quantification method, based on the titration procedure. 5 g of wheat flour were placed in a beaker to which 50 mL of neutral 90% ethanol were added. The solution was then mixed and left to rest for 24 h. The solution is then filtered on filter paper. Then, 10 mL was separated from the filtered solution and titrated with 0.01 N of sodium hydroxide until it turned pink, using phenolphthalein as indicator [10]. Calculate the percentage of alcoholic acidity as sulphuric acid using (3).

$$Alcoholic\ acidity\ (\text{as}\ H_2SO_4) = \frac{24.52 \times A \times N}{W} \quad (3)$$

where N = normality of standard sodium hydroxide solution; A = volume of standard sodium hydroxide used in titration (ml); W = weight of sample (g).

4) Determination of gluten

The gluten content was determined as described in Method 38-10 of the AACC [11].

Using this method, a dough is prepared by hand-mixing a flour sample with water and then allowed a resting period. The dough is then kneaded under a stream of water to remove starch, water-soluble pentosans and water-soluble proteins (albumins and globulins).

The amount of gluten remaining is expressed as a percentage of the original starting material representing the wet gluten content. The wet gluten can then be dried to determine the dry gluten content. The wet gluten content was calculated using (4).

$$G_w = \frac{g}{P} \times 100 \quad (4)$$

where G_w = wet gluten content (%); g = weight of wet gluten (g); P = weight of sample (g).

5) Determination of water activity

Water activity (Aw) was determined with a water activity meter (LabStart portable aw meter from Novasina). After standardizing the apparatus with humidity calibration standard, pour the wheat flour into the sample cup and place it in the instrument. The aw value measurement appears in a few minutes, as the instrument has built-in automatic equilibrium detection and proven resistive-electrolytic sensor technology.

C. Microbiological Load

The evaluation of the microbial quality of wheat flour is based on the classical method of decimal dilution followed by the quantitative determination of microorganisms. Ten grams (10 g) of wheat flour were collected aseptically and placed in a 100 mL flask containing 90 mL of sterile BPW (Buffered Peptone Water). The mixture was homogenized and diluted using successive decimals. The number of total aerobic mesophilic microflora were determined by placing in standard media in Petri dishes, respectively, in PCA (Plant Count Agar), PDA (Potato Dextrose Agar), Capek and Mc Concey medium, incubation temperature 30 and 37 ºC for 72 hours. After counting the colonies in the Petri dishes, the result was expressed in Colony-Forming Unit (CFU)/g of sample, according to the standard ISO 7932:2004 standard.

III. Result and Discussion

Results of the analysis of the physico-chemical properties of six samples of wheat flour produced by a milling company are reported in Table I.

A. Moisture Content and Water Activity

Moisture content in flour is an essential measure of quality control, is very important regarding its shelf life. Regarding moisture content shown in Fig. 1, the results range from 12.00 to 12.55 %. We can see that all the samples have a moisture content lower than the 14.5 % standard in EC No 687/2008 [12]. Low moisture content in flour increases its storage stability.

TABLE I: Summary of Physico-Chemical Parameters

Samples	Moisture (%)	Water activity	Fat acidity (%)	Ash (%)	Gluten (%)
White flour	12.47	0.62	0.149	0.65	30.60
Brown flour	12.42	0.62	0.217	1.24	34.37
Pie flour	12.55	0.62	0.091	0.68	27.27
Pizza flour	12.54	0.58	0.080	0.46	29.31
Semi-integral flour	12.00	0.58	0.205	1.16	32.41
Integral flour	12.37	0.61	0.126	1.29	32.78

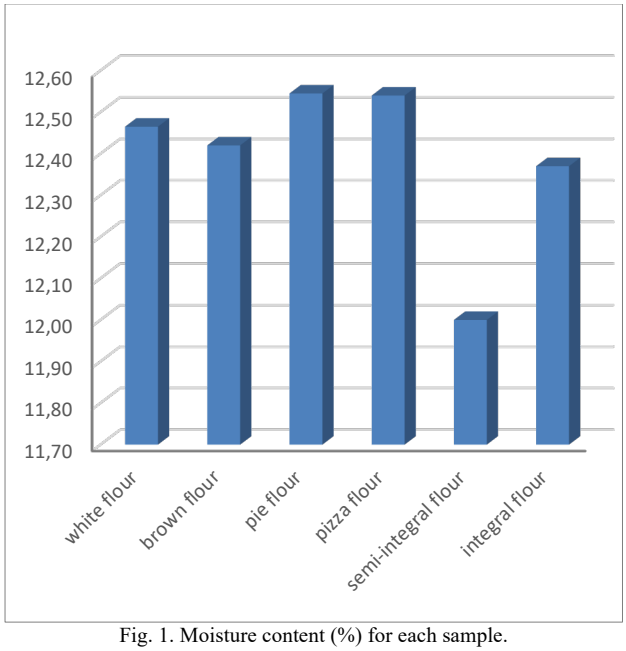

Fig. 1. Moisture content (%) for each sample.

Water activity is another parameter that affects food quality, both to inhibit microbiological spoilage and to protect product quality. For these reasons, it is recommended that the water activity values in wheat flour be less than 0.65 [13]. In all the wheat flours analyzed the water activity was lower than 0.65, ranging exactly from 0.58 to 0.62 shown in Fig. 2.

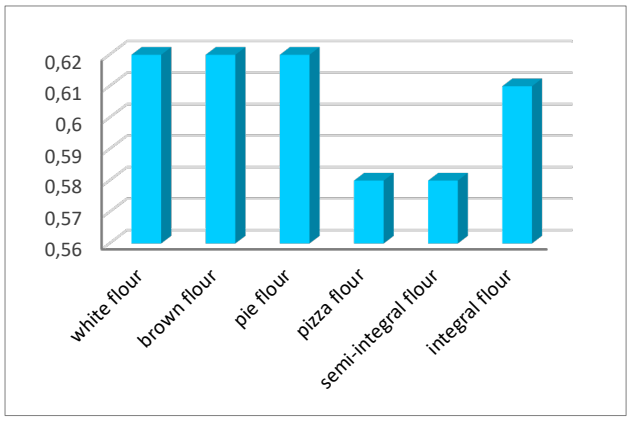

Fig. 2. Results of water activity for each sample.

Based on the results of moisture content and water activity presented in Fig. 3, it is shown that the differences are very small between the 6 samples analyzed for these two parameters.

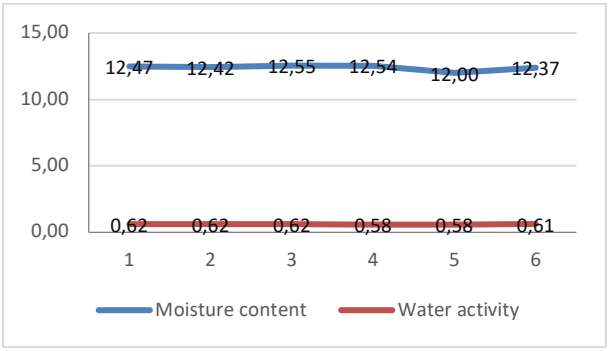

Fig. 3. Comparison of moisture content and water activity.

B. *Alcoholic Acidity*

The results of alcoholic acidity (fatty acidity) presented in Fig. 4, showed that all samples have a low value, ranging from 0.080 to 0.217. These results confirm that the flour samples are fresh, because fat acidity is another indicator of the degree of freshness of grain and products of its processing.

The highest values are found in brown and semi-integral wheat flour, because these types of flour include some of the grain's germ that contain fatty acids. But we see that this is not observed in integral flour because the value of its alcoholic acidity is lower.

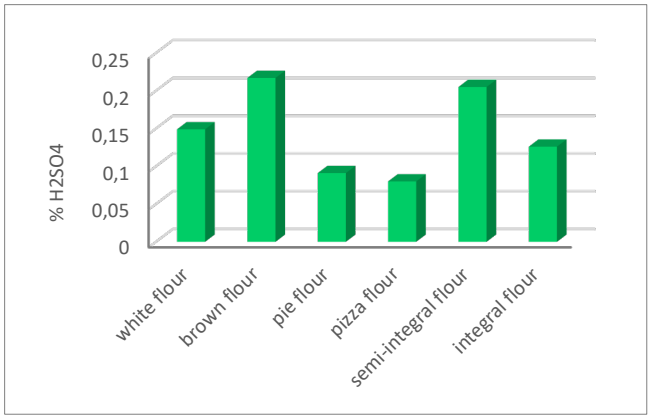

Fig. 4. Alcoholic acidity for each sample.

C. *Ash Content*

As shown in Fig. 5, the ash content ranges from 0.46-1.29 %. The sample with the lowest ash is pizza flour with 0.46 %, followed by white flour with 0.65 % ash. The samples that have higher ash values are brown and integral flour with 1.24 and 1.29 %, respectively. Brown and integral flour are the types of wheat flour that contain most of the germs and bran from the wheat grains, which are rich in minerals.

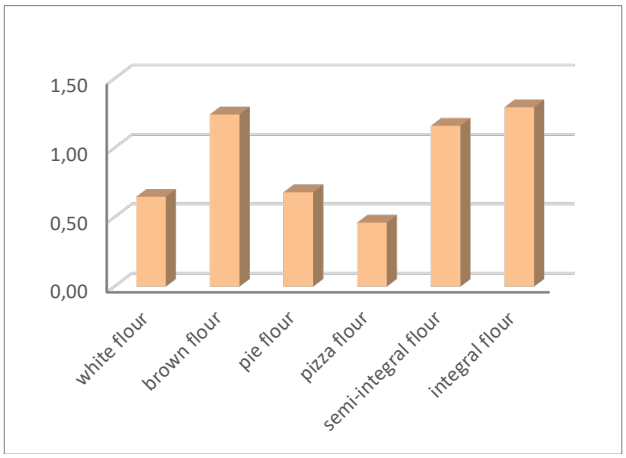

Fig. 5. Results of ash content for each sample.

D. *Gluten Content*

The determination of gluten in wheat flour has shown that the value ranges from 27.3 to 34.4%. In Fig. 6 the pie flour has the lowest wet gluten content 27.27 %, followed by pizza flour with 29.31 %. The types of flour that have the most gluten content are brown, integral and semi-integral flour with 34.37 %, 32.78 % and 32.41 % respectively. All the samples present good values of gluten content.

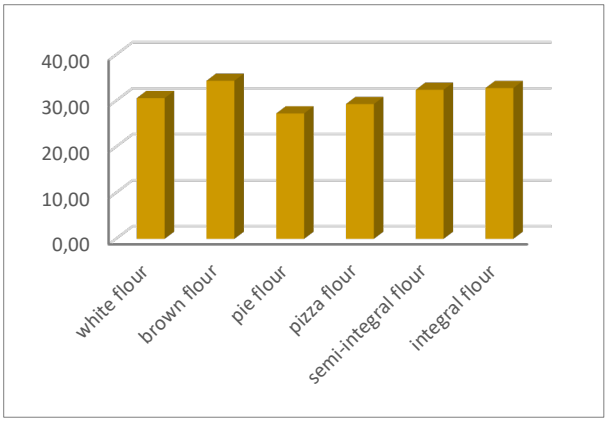

Fig. 6. Results of gluten content for each sample.

E. *Microbiological Quality*

Examination of the microbiological quality of wheat flour samples was carried out to obtain an idea about the hygienic quality and microbiological load. For this we analyzed the total mesophilic aerobic bacteria and the results for each sample are presented in Fig. 7.

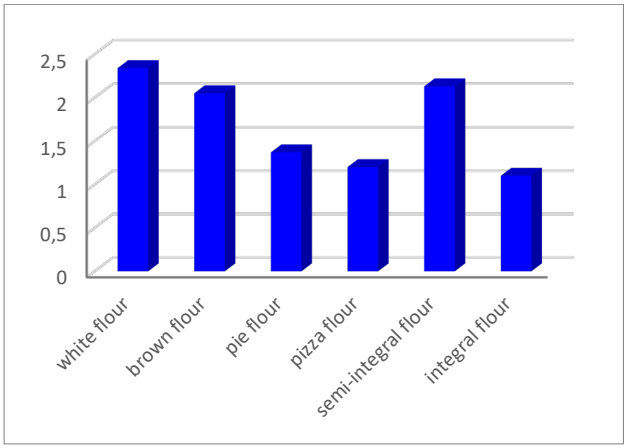

Fig. 7. The logarithmic values of total mesophilic aerobic bacteria for each wheat flour sample.

The results of enumeration of a total mesophilic aerobic bacterium in all flour samples studied were from 1.10 to 2.34 Log CFU/g. Bacteria of the genus *Pseudomonas spp*. *Flavobacterium spp*. and *Bacillus spp.* are mainly dominant. White flour, brown and semi-integral flour have the highest total microbial load, then the other samples. Microorganisms are constant contaminants of wheat flour because they originate from the field (such as harvesting, transport, storage), milling process, hygiene practices and moisture content, that affect their microbial load.

All samples were below the maximum acceptable limits of the Codex Alimentarius (FAO-Food and Agriculture Organization) [14], because the flour samples are all freshly ground. Also, the lower microbiological load is associated with the lower moisture content and water activity.

IV. Conclusion

After analyzing 6 different samples of wheat flour, we reached the following conclusions:

- Regarding the moisture content and water activity, all the samples were below the standard 14.5% and 0.65, respectively.
- Alcoholic acidity values were low, but it is worth noting that brown flour and semi-integral flour had the highest values, because their composition includes the germ of the grain.
- The type of flour can be clearly distinguished by the percentage of ash, because the ash content is higher in brown, integral and semi-integral flour, normally these flours have the highest mineral content.
- All flours analyzed have a good gluten content of 29-34%, except for pie flour, which has the lowest value (27.27%).
- Regarding the microbiological load, all the flours analyzed resulted in a content of total mesophilic aerobic bacteria lower than the standard.
- We conclude that all analyzed flours were of a good quality for the measured physico-chemical and microbiological parameters.

Conflict of Interest

The author declares that she does not have any conflict of interest.

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