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THE IMPORTANCE OF MAIN COMPONENTS OF GRAINS ON BAKING QUALITY OF WHEAT

Anna Nowotna[1], Halina Gambuś[1], Peter Liebhard[2], Werner Praznik [2], Rafał Ziobro[1], Wiktor Berski[1], Anna Cygankiewicz[3]

[1]*Agriculture University in Cracow, Poland*
[2]*Agriculture University in Vienna, Austria*
[3]*Institute of Plant Breeding and Acclimatization in Cracow, Poland*

ABSTRACT

Properties of grain and starch from varieties of wheat with different technological quality were measured. It appeared that besides the well known wheat properties such as high gluten content and medium enzymatic activity, the content of soluble carbohydrates is also important from the baking point of view. Moreover, medium solubility, not too low phosphorus content and high molecular mass of starch (isolated from wheat varieties) are essential to good quality of wheat.

Key words: wheat, technological value, chemical components, physico-chemical properties of starch.

INTRODUCTION

Wheat varieties are qualified to different classes: fodder, bread, hard-durum, which exhibit different applications. Those varieties differ in quantity and quality of proteins, mainly gluten. This component of wheat and wheat flour results mainly from unique properties of dough and volume of bread.

The main components of cereal and flour are carbohydrates. Water soluble carbohydrates as mono- and oligosacharides, fructans, pentosans influence the water binding capacity and are nutrient for baking yeast [12]. Pentosans influence bread volume depending on their composition, structure and origin [12, 17, 19].

Starch, the main carbohydrate component, is important in establishing dough structure [4, 12, 16]. Swelling and gelatinization properties of starch as well as surface properties depend mainly on granule integrity. According to the Sandstedt [4] theory, such water binding capacity is important, that ensures a proper contact with gluten with a simultaneously maintained integrity of starch granule.

In strenthening the gluten net [4, 12], that developed during mixing, flour lipids, particulary glicolipids as well as phospholipids, play the essential role.

However, the is observed lack of extensive research which would define what differences between starches from different wheat varieties are responsible for their baking quality. Eliasson [2] et al. based on thermal analysis of wheat flour (DSC) conclude that higher gelatinization temperatures (g.t.) and low gelatinization starch enthalpy (ΔH_{gp}) improve baking properties. In durum varieties the values of g.t. are high and ΔH_{gp} low, in fodder wheat varieties t.g-low and ΔH_{gp} high while in bread varieties these numbers are average. Molecular characteristics of wheat starches from different wheat varieties were also studied. Kobayashi [10] et al. did not observe the structural differences between amylopectins from different wheat starch classes. Higher molecular weights were observed by Wootton and Mahdar [18] in starch from hard wheat in comparison to starch isolated from soft ones.

The chemical composition of wheat grains of various technological quality, especially their carbohydrate fractions, and physico-chemical properties of isolated starches, were examined In this work.

MATERIAL

Four wheat varieties, cultivated in Gerasdorf (near to Vienna) and clasified to different classes, were used in our studies: Renan (A 8-9), Capo (A 7-8), Ikarus (B 4-5) and Hai (C).

In these cereals there were estimated: falling number using Falling Number - 1800 Perten [6], total protein content (N x 5,7) using NIR method in Infratec 1255 Tecator, total pentosans content [1] and crude fiber [7]. In those samples there were measured water soluble carbohydrates by shaking 0.1 g sample with 50 cm^3 of distilled water for 0.5 h. Then after centrifugation for 5 min using 1250 x g, soluble carbohydrates in supernatant were measured by anthrone method using 540 nm [13]. Carbohydrates soluble in ethanol were measured by shaking 0.1 g sample in 10 g of this solvent for 1h. Next the sample was centrifuged for 5 min using 1250 x g and soluble carbohydrates were estimated in supernatant as used in previous method. The sum of carbohydrate [3] and starch [8] contents were also measured.

In flour obtained from a laboratory mill: wet gluten using Glutomatic - 2200 Perten [9] and gluten index [9] were estimated.

From flour the starch was isolated by laboratory method [15]. Starch was next subjected to following analyses: total protein in apparatus KJELTEC Auto II Plus Tecator (N x 5.7) [15], total phosphorus content [11], apparent amylose content [14] as well as swelling [15] and pasting characteristics [5]. To obtaine molecular mass high pressure SEC was performed with a series of TSK columns (PWM + 6--- + 5--- + 4000 + 3000; 30 + 30 + 30 + 30 x 0.75 cm, Toyo Soda) connected with dual detection of mass DRI: Optilab 903, Wyatt Tech./US) and scattering intensity (LALLA: KMX-6, TSP/US). Absolute molecular weight was calculated according to following equation:

$$M = [\ K.c / R_0 - 2\ A_2.c]$$

All analyses were performed in dublicates then, LSD coefficient was calculated.

RESULTS AND DISCUSSION

Wheat varietes differed in amylolytic activity, which was measured as falling number (Table 1). Only Reanan and Capo varieties exhibited medium amylolytic activity, what is important as baking is considered. Among all wheat varieties Renan showed the highest amount of protein, wet gluten and also gluten index (Table 2). The weakest gluten was in Hai variety (gluten index = 80%).

Table 1. Amylolytic activity of wheat varietes

Wheat variety	Falling number [s]
Renan	277
Capo	279
Ikarus	164
Hai	300

Table 2. Content and quality of protein in wheat varietes

Wheat varietiety	Content of [%]		Gluten index [%]
	Total protein	Wet gluten	
Renan	13.2	26.1	98.5
Capo	12.4	23.2	97.4
Ikarus	13.0	22.2	96.8
Hai	12.1	22.0	80.0

Statistical analysis (LSD) exhibited, that all investigated varieties of wheat had similar content of the following carbohydrates fractions (Figs. 1 and 2): total carbohydrates, starch, total pentozans, water soluble polisaccharides, alcohol soluble carbohydrates (so called low molecule carbohydrates). Water soluble polisacharides were calculated by the substraction of alcohol soluble carbohydrates from water soluble carbohydrates. When reffered to crude fiber Hai variety (similar in this aspect to Ikarus variety) had higher value than any other. Moreover, the above mentioned varieties were characterized by the lowest amount of water soluble carbohydrates.

Summarizing all data presented on properties of wheat varieties we can conclude that Renan was characterized by: the highest protein and gluten contents, gluten index and amount of soluble carbohydrates amount as well as medium amylolytic activity and lowest crude fibre. In contrast with this were the properties of Hai variety.

Physicochemical properties of starches isolated from wheat varieties are in Figures 3–5.

Fig. 1. Total carbohydrates and starch content

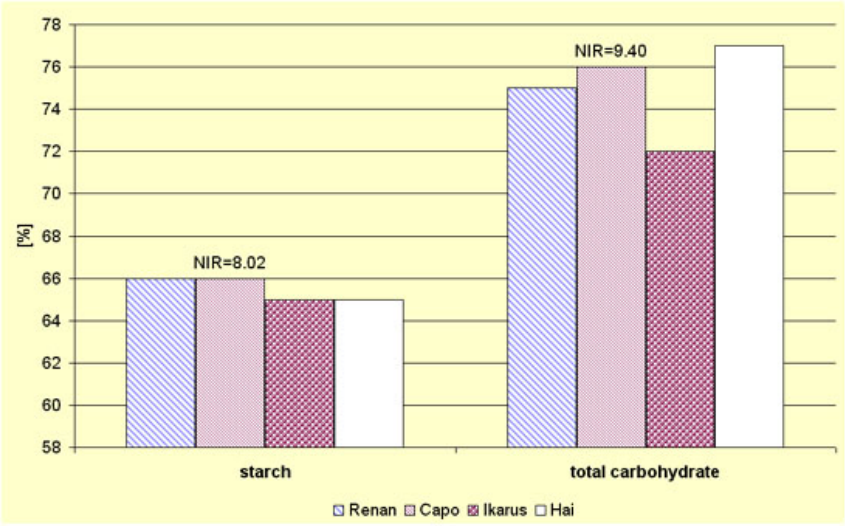


Fig. 2. Carbohydrate fractions

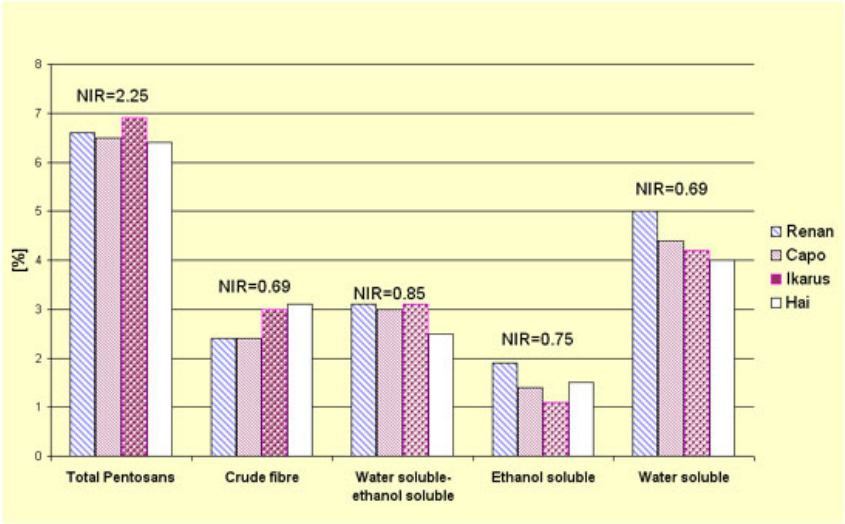


Fig. 3. The content of phosporus and protein in starch

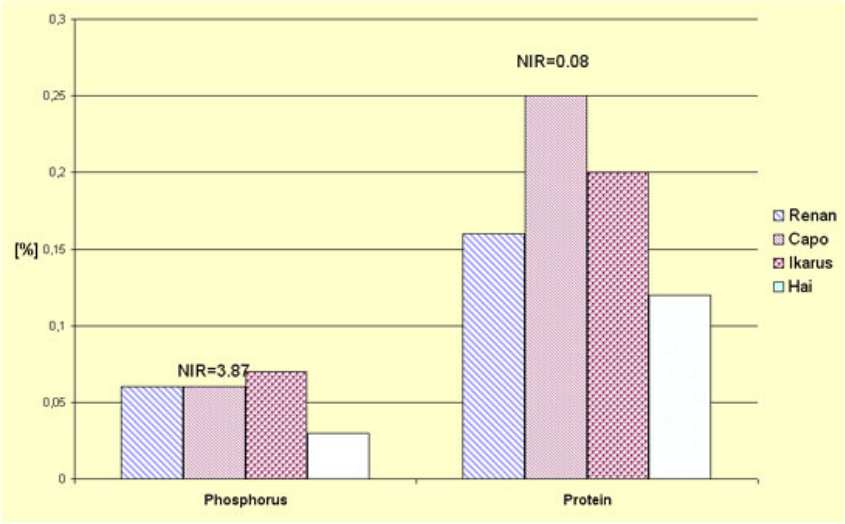


Fig. 4. Solubility [%] and water binding capacity of starch [g/1g db]

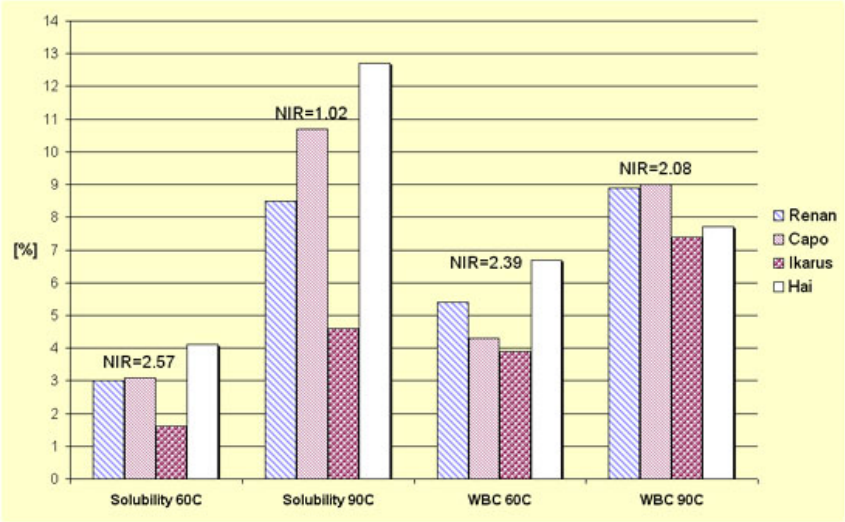
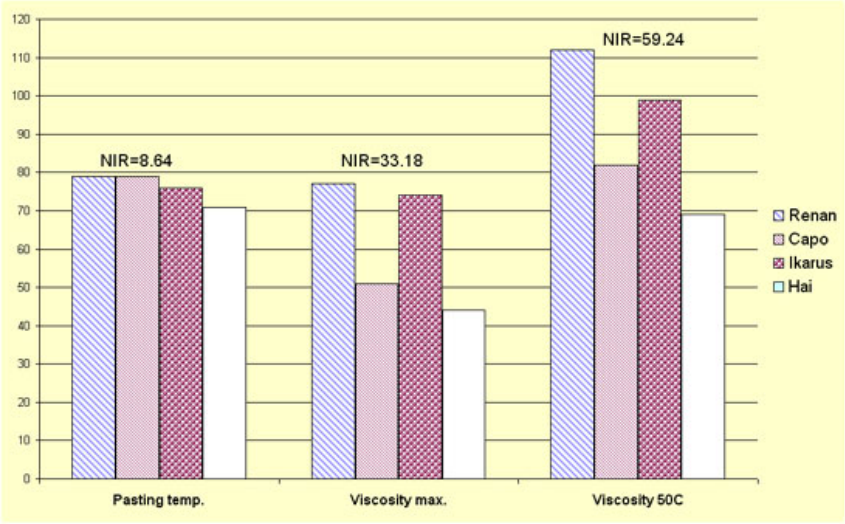


Fig. 5. Pasting characteristics parameters



The content of the nonstarch substances in wheat starches were presented in fig. 3. LSD values calculated showed that starch isolated from variety Hai was characterized by the lowest starchy phosphorus content, that proved the lowest starchy fat content [14]. Investigated starches differed significantly with total protein content (0.12% to 0.20%).

Swelling and pasting properties of wheat starches were presented in Figures. 4 and 5. Statistical analysis showed that Hai variety starch was characterised by the highest value of water binding capacity at 60°C, and solubility at 90°C. Starch from Renan variety showed average solubility at 90°C. Investigated wheat starches did not differ among themselves in respect of pasting characteristics (Fig. 5).

Molecular properties of the investigated starches were presented in Table 3. The highest value of the molecular mass had starch from Renan variety, the highest apparent amylose content (LSD = 1.51) was measured in wheat starch from Ikarus variety.

Table 3. Content and quality of protein in wheat varietes

Wheat variety	Content of apparent Amylose [%]	Molecular weight [10^6 g/mol]
Renan	18.4	11.80
Capo	17.5	8.95
Ikarus	21.2	8.94
Hai	16.9	9.71

Summing up it can be concluded that Hai variety was characterized by: the lowest phosphorus (phospholipid) content, the highest solubility and water binding capacity. Different were the properties of starch isolated from Renan variety: high phosphorus content and medium solubility in water. Moreover, this variety was characterised by the highest molecular mass.

Making a summarry of the all obtained results one may confirm, that such grain properties like: high gluten and water soluble carbohydrates content, and average enzymatic activity and average molecular mass, not low phosphorus content (phospolipids) and high molecular mass of starch were characteristic for Renan wheat variety Renan, that belongs to A class (8-9). Average starch solubility provides it with proper contact with gluten, with keeping its integrity [4, 12, 16], and starchy lipids streghtened gluten net [4, 12]. The highest bread volume can be obtained from flour of this variety. Hai variety was characterized by weak gluten, high crude fiber content and low water soluble carbohydrates content, and moreover low starchy phosphorus content, high solubility and water binding capacity, that produces bread with low volumne, and for that reason was classified as C class.

Obtained results have shown the important role of quality and quantity of gluten and water soluble carbohydrates in bread structure and crumb creation. Moreover in this structure creation starch plays also significant role, especially important its ability to be soluble in water, lipid content and molecular mass.

CONCLUSIONS

1. Besides the well known factors in evaluation of wheat quality from baking point of view, such as quantity and quality of gluten, soluble carbohydrate fraction is worth paying attention to.
2. Medium solubility as well as not low phosphorus (lipid) content of starch are very important for the baking properties.
3. Starch isolated from wheat vatietes Renan, belonging to the best A – class, is characterised by the highest molecular mass.

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Anna Nowotna, Halina Gambuś, Rafał Ziobro, Wiktor Berski
Department of Carbohydrate Technology
Agriculture University in Cracow
29-Listopada 46, 31-425 Cracow, Poland
tel./fax: (+48 12) 633 62 45
e-mail: rrnowotna@cyf-kr.edu.pl
