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QUALITY ASSURANCE OF CEREALS – PAST, PRESENT, FUTURE

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Abstract

The today accepted requirements and the system of quality assurance is a result of long-term development starting with food regulations of ancient societies, continuing with activity of Trade Guilds in Middle Ages and with the beginning of modern food legislation in 19-th century till today's harmonization of food standards at international level.

The problems of quality assurance in connection with globalization and present situation in Central East-European countries as well as the future trends in quality assurance are discussed. Particularly the food safety requirements, breeding technologies, functional foods, and new analytical and quality control methods are investigated.

Keywords: wheat, cereals, quality, quality assurance, food safety, quality control methods.

1. Introduction

According to glossary of terms of EOQC (European Organization for Quality Control) quality assurance means *a system of activities whose purpose is to provide assurance and show evidence that the overall quality control job is in fact being done effectively.* Another definition is more clear for the consumer *all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.* In every case it could be concluded: (I) quality assurance includes a series of systematic actions; (II) it is strongly connected with standards and quality control methods.

Coming now after these general remarks to the cereals, the system of quality assurance includes *breeding, growing, prestorage manipulation, storage, transport and in wider sense also processing and distribution of products.* In the framework of this paper we will investigate the process until the phase of the silo of the mill or before loading the grain into export vessels. The wide variability in climate of different continents, regions and countries, the diversity of cultures and traditions results in differences in types, processing methods and consumption of cereals. Taking in mind the aims of this conference I would like to discuss the problems of quality assurance of wheat and rye, the most important cereals used for food purposes in Central Europe.

Until sixties of 20-th century a simplified and generalized view was commonly accepted concerning the wheats grown in Europe. The wheats grown in Western Europe (e.g. in such countries as Germany, France or United Kingdom) were known as high yielding, soft wheat varieties with relatively low gluten content in contrast to hard winter and/or spring wheat cultivars grown under continental climatic conditions (e.g. Hungary, Ukraine, Russia) having lower yield but high gluten content. In addition it was the general opinion that Western-Europe is a wheat importer.

This generalized view, which was valid some decades ago is now changing due to great progress in successful efforts in several countries to increase yield and quality of produced wheat. The progress mentioned above is the result of successful work of researchers, breeders and producers and also of agricultural policy as well as developments in classification and quality control system of wheats.

Rye is a special European kind of cereal. More than 95% of the world production is grown in Europe. From the total world production (80 mio tons/year) CIS countries (Russia, Belarus, Ukraine, Moldavia) produce 44% of the world rye crop. In EU Germany and in Central East European (CEE) countries Poland is the main rye producer. Among smaller producers Scandinavian countries (Denmark, Sweden, Finland), Baltic countries, Czech Republic, Slovakia, Hungary, Slovenia and Macedonia may be mentioned. The period after second World War was a period of declining rye production and consequently that of rye related research. During last ICC- EU Conference in Vienna some proposals were made in order to initiate improvement in this field.

In the framework of this paper some characteristic features of wheat and rye production and quality assurance will be summarized.

2. Wheat and Rye Production

In Western Europe, nearly all countries overproduce wheat due to the increase of production in the post-war period (SEIBEL [1]). This increase is connected only in small amount with increase of the area used for wheat growing, the main factor was the growing yield. For example in France the average yield was about 3.5 t/ha in 1970 and in 1995 it reached a value of 6.7 t/ha. In Germany the wheat production is four times higher than it was in the sixties although the area of wheat cultivation increased only with about 50% in the same period. Even Austria with a wheat production of 1.2 million tons per year not only covers the need of the country, but allows some export.

Within the Common Market (*Table 1*) (SEIBEL [1], SALOVAARA and Kjell M. FJELL [2]) France has the highest volume of wheat production with about 30 million tons per year, followed by Germany and UK. Netherlands has the highest yield with 8 tons per ha, followed by Ireland and United Kingdom with about 7 tons/ha. Italy has the highest rate of wheat usage for human nutrition with nearly 6 million tons, followed by Germany (5 million tons), the United Kingdom and France with about

Table 1. Wheat production in EC (1000 tons/year)

Country	Common wheat	Durum wheat
Austria	1.200	60
Belgium	1.252	–
Denmark	3.086	–
Finland	430	–
France	30.837	1.870
Germany	15.517	62
Greece	858	1.700
Ireland	695	–
Italy	4.376	4.524
Netherlands	1.020	–
Portugal	253	28
Spain	2.954	1.210
Sweden	1.715	–
United Kingdom	14.212	–
EC Countries	82.000	9.460

Table 2. Wheat production in some CEEC countries

Country	Wheat production (mio tons/year)
Albania	0.5
Bulgaria	3.0–4.0
Croatia	1.0–1.5
Czech Republic and Slovakia	3.0–4.0
Hungary	4.0–5.0
Poland	6.0–9.0
Romania	4.0–9.0
Yugoslavia	2.0–3.0

4.7 million tons. United Kingdom and France have the highest rate of wheat usage as animal feed with about 4 and 3 million tons, respectively.

Durum wheat production of EU is concentrated in Southern Europe, some countries do not grow durum wheat at all (*Table 1*). Italy has the highest durum wheat production with 4.5 million tons, followed by France and Greece with 1.9 and 1.7 million tons, respectively. France and Germany have the highest yield with 4.4. tons per hectare. The yields in Italy, Spain and Greece are much lower.

Several countries of Central- and Eastern Europe (Russia, Ukraine, Poland,

Hungary, Romania) are important cereal producers (*Table 2*). Since the 60-ies efforts were made to increase the yield/ha and also the total production of wheat. As a result of these efforts the production increased particularly in some Central-East European countries such as Hungary. Political and social changes after the 90-ies resulted in a decrease of wheat production, however it seems now that the situation in cereal growing is stabilized and the efforts are concentrated on improvement of quality and effectivity of production.

As mentioned earlier, the world rye production is now only about 30 mio tons per year. Greatest part is produced in Europe. CIS countries, Poland and Germany are the main rye growers, the production of Scandinavian, Baltic and some CEE countries (e.g. Czech Republic, Hungary) is much smaller.

3. Quality Assurance of Wheat and Rye

Although the selection of new varieties from wild ones and the development of storage facilities for cereals in ancient Egypt, China, India, Greece and Roman Empire may be treated as earliest activities of quality assurance of cereals, the development of system of quality assurance of cereals in today's sense started at the end of 19-th century and beginning of 20-th century. This was the period of beginning of new effective systems of breeding, development of method of determination of gluten content in wheat, study of its quality, invention of different apparatuses for study of dough rheology on the one hand and of start of food legislation, quality control at state level and standardization on the other hand. Since this time the quality assurance activities are strongly connected with developments in control methods and newer and newer quality requirements included in the regulations and standards. In the following the main features of quality assurance systems will be discussed through models used in some selected countries.

4. The Canadian System of Quality Assurance

May be it is surprising that a review of quality assurance systems at a European conference starts with a system used in a non European country. The reason of such a decision is that the Canadian model represents a centralized system, which is highly regulated by the federal government through the Canadian Grain Commission (CGC). This system of quality assurance of wheat has evolved over more than hundred years under rigorously controlled conditions. The system assures that the grain will be of consistent intrinsic quality and will be free of undesirable contaminants. Quality is controlled by intervention at four critical points in the system: breeding of improved wheat varieties, quality assurance during production (e.g. choice of variety as seed, chemical treatment), delivery of wheat to country elevators and its classification and grading, final quality control at terminal elevators (CGC issues a 'Certificate Final').

Kernel visual distinguishability (KVD) is the cornerstone of classification. At present Canada has seven official classes:

- Canada Western Red Spring (CWRS)
- Canada Western Red Winter (CWRW)
- Canada Western Extra Strong (CWES)
- Canada Prairie Spring Red (CPSR)
- Canada Prairie Spring White (CPSW)
- Canada Western Soft White Spring (CWSWS)
- Canada Western Amber Durum (CWAD)

The factors allowing the use of a such simple method of classification as KVD are the following:

- only the new varieties meeting criteria of existing classes of KVD could be registered and used by farmers
- relative stability of climatic conditions
- good stability regarding quality of existing classes
- growing the best varieties for regions

Grades within a class are determined based on following factors:

- test weight
- varietal purity
- vitreousness
- soundness/maturity
- foreign matter

5. Quality Assurance in Europe

In Europe there is no such relatively simple system based on KVD of varieties grown. This is caused by significant differences of climate, high number of varieties grown (this is particularly valid for CEE countries), wide sortiment of cereal based foods. Nevertheless, it could be generally stated that in the last decades a continuous improvement of wheat quality was achieved in some countries. From this point of view the development in German wheat production may be primarily mentioned. Due to the high demand for flour quality, efforts of breeders to apply new achievements of genetics and molecular biology and the price policy in Germany during the last years there has been a continuous increase in protein content and sedimentation value. The progress in improvement of quality may be confirmed by the fact that in 1992 more than 35% of wheat in Germany had a protein content higher than 14% d.m. and less than 5% of the wheat crop had this value lower than 9.5% (SEIBEL [1], SEIBEL and ZWINGELBERG [3]). In 1995 more than half of wheat was classified as elite and quality wheat (SIEVERT and GERSTENKORN [4]). Although in majority of CEE countries the efforts were concentrated to increase the

total production and yield for a long period, a growing number of initiatives and efforts may be recently observed in relation with quality improvement.

In Europe there is no uniform system of quality assurance of cereals. Both governmental and private companies are involved in the breeding of cereals, however, new varieties are generally approved by governmental institutions.

In some countries (e.g. Norway) the governmental grain boards have a decisive role in wheat storage, export and import and are in close cooperation with commercial flour mills in order to maintain a balance and continuity of wheat and flour quality. In other countries no such centralization exists, although some regulations and guidelines were established or are in preparation. This is also valid for CEE countries. In many cases the seed planted by farmers is not of a registered variety . This fact together with low level of agrotechnique and shortage in grain storage capacity hinders the effective quality assurance.

To improve the situation there is a need for development of new varieties with greater stability in yield and quality under fluctuating climatic conditions. An investment into extension and modernisation of storage capacities is also necessary.

The wheat classification in Europe does not differentiate between soft and hard wheat, but between common and durum wheat. Concerning the common wheat, in majority of countries, a distinction is made between wheat for food purposes and wheat for animal feed. Generally minimum requirements are specified for food grain to be sold in the market. E.g. in EU the requirements include [5, 6]:

- normal color, sound smell, absence of living insects
- limit of broken, shrunken and infested kernels, weed seeds and spoiled kernels
- minimal Falling Number value
- minimal total protein content

It is characteristic, particularly for Western- and Northern Europe, that the *occurrence of sprouted kernels and consequently the high alpha-amylase activity* (measured by Falling Number value) play an important role in grading. Another characteristic feature of quality control, in addition to protein content (gluten content), are the *properties (quality) of wet gluten* that are also studied and measured.

Rye standards of rye producing countries also make distinction between food grade rye and that used for feeding animals. The grading factors included in the EU standards are: moisture, broken kernels, grain besatz (shrunken kernels, other grains, insect-damaged kernels), sprouted kernels, black besatz (wheat seed, ergot, unsound grain, chaff, impurities) and hectoliter weight. In Russia color, odour, taste, moisture, foreign kernels, damaged kernels are listed as grading factors.

An important tendency of quality assurance of cereals in Europe is the *growing role of requirements connected with food safety.* The resistance against diseases (including Fusarium resistance), and the lower need for mineral fertilizers are important requirements in breeding new varieties. A growing interest may be observed concerning the use of *integrated pest management system (IPM) and organic agriculture.* At present strict *regulations* exist concerning production and use of *genetically modified cereal grains.*

The wheat (and rye) classified as food grade grain is divided into subclasses based on characteristics influencing the quality of end-products. Although the methods generally used include determination of protein, rheological investigation of dough and baking test the instruments used and the specified limits vary depending on the typical end-products of country. Farinograph is the most generally used instrument for study of rheological properties of dough. As examples the quality classes accepted in Germany and Italy and their characteristics are shown in *Tables* 3 and 4.

Table 3. Wheat classification system in Germany

Parameter	Quality class			
	Elite *E*	High quality *A*	Normal *B*	Soft *K*
Protein (%) min.	13.8	13.2	12.8	12.4
Sedimentation (ml) min.	47	33	26	19
Flour yield (%) min.	76	74	74	76
Water absorption (%) min.	56.9	55.9	53.7	52.6
Falling number (sec) min.	285	255	255	235
Loaf volume (ml/100g) min.	710	650	590	560

Table 4. Italian system of classification of common wheats

Class	Alveograph		Protein $N \times 5.7$	Farinograph stability	Falling number
	W	P/L	(%)	(MIN)	(SEC)
Improver	300	1	14.5	15	250
High quality	220	0.6	13.5	10	220
Normal bread wheat	160	0.6		5	220
For confectionery products	115	0.5		–	240

In France, the quality of the wheat is based on those flour quality attributes desirable for production of popular baguette-bread. A flour protein level of 11.0–11.5% is necessary. A W-value of 211 determined by alveograph shows a good baking strength, especially suitable for French bread.

In Hungary the bread wheats are graded according to farinographic value and improver (A1, A2) , first grade (A2, B1), second grade (B1, B2) and third grade (B2, C1) grain is distinguished. The corresponding Falling Number values are: over 300 sec, minimally 250 sec, minimally 230 sec, and minimally 220 sec. Wet

gluten content and its quality plays also a role in quality evaluation.

In Poland the wheat cultivars are divided in three groups (LEMPKA [7]): (a) Western-European-type soft winter wheats; (b) red and white winter wheats (Middle-European-type) of variable baking strength; and (c) hard red winter wheats of Russian – prairie – type with good baking quality. The laboratory baking test is the key factor in determining the baking quality of flour. Determination of wet gluten content and its quality, as well as alpha-amylase activity are also common measures.

In Great Britain the average protein content of domestically grown wheat is 11.5–12.0% d.m. (SPENCER [8]). For the known Chorleywood process a protein level of about 12.5% is needed. To obtain this protein level, high-protein wheat is imported or vital gluten is used.

The high-quality wheat according to regulations in Austria has a specific weight of 80 kg/hl, a minimal protein content of 14.0% and a wet gluten content of 33%. High sedimentation value (40–50 ml) and Falling Number (240–250 sec) is required. For normal bread wheat the corresponding values are: 79 kg/hl, 12.5%, 28%, 35 ml, and 220 sec, respectively.

Concerning the methods used for quality evaluation, EU regulations exist only for some basic methods connected with the determination of moisture, purity (foreign material, broken kernels etc.), and soundness (insects, sprouted grain, fusariosis etc.). Due to diversity of bakery products in EU and other countries and also due to the traditions, different methods are used for bread-making quality determination of wheat and rye recommended by ICC, AACC, ISO and CODEX. Parallelly with extending the EU a harmonization process may be observed.

6. What Should be Improved. Future Trends

Taking in mind that the first prerequisite of assurance of high quality of cereals is the efficient breeding, great attention should be paid to this activity. Development of new varieties with greater stability in yield and quality under different environmental conditions, including the effects of climate change should be a priority.

As mentioned in the previous part of this paper, the food safety aspects play an increasing role in quality assurance . Consequently, it seems that a further development may be expected in methods of control of microbiological status of cereals including mycotoxin control. Clarifying the problems connected with potential dangers of transgenic cereals is also an important task.

An investment into extension and modernisation of the storage facilities may be also a factor of improvement in conditions of quality assurance.

The growing number of cereal-based functional foods needs methods suitable for determination of declared biologically active components connected with the advantageous effect of such foods.

From methodological point of view, efforts are needed and success is expected in use of rapid and nondestructive methods such as near infrared (NIR) technique,

digital image analysis (DIA), immune techniques, and DNA-based procedures. From the point of view of breeding, the small scale rheological instruments and new molecular techniques may be of future importance.

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