Chapter 3

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FAM-FMC SYSTEM AS AN ALTERNATIVE ELEMENT OF THE SOFTWARE USED IN A GRAIN AND FLOUR MILLING ENTERPRISE

Abstract: Nowadays, processes of computerization have become a standard in production plants. Implementation of these processes is aimed at limitation of the activities which have so far been performed manually. Dedicated computer systems are being developed according to the requirements imposed by concrete enterprises with consideration of their manufacturing specificity. These adjusted systems facilitate and accelerate production and improve its performance while helping maintain final product at an unchanged quality level. Flour mill laboratories use the software to record and facilitate computation of the measurements. This study is aimed at analysis of the opportunities for implementation of the FAM-FMC system as a tool to support production of flour with parameters that match specific customer expectations.

Keywords: Grain and flour milling industry, quality, flour, production support systems.

3.1. Introduction

In order to properly develop and implement a system for support of production processes (including logistics and quality processes), one should consider individual stages in production of a specific product.

In a flour mill, the production cycle begins with acceptance of raw materials. A representative sample is always taken from each delivery that arrives at the plant. Next, the samples are tested in a laboratory. The grain is subjected to basic analysis. The parameters determined include (JURGA R. 2009): humidity, density, uniformity, contaminants, protein content, gluten content, falling number, sedimentation and hardness.

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If the basic results suggest a very good quality of the grain, additional rheological tests are also carried out. Depending on the parameters met by grain, the grain is classified for production of a particular type of flour (Gąsiorowski H. 2004).

Before grain is accepted for individual chambers or containers, it must be processed in special grain cleaning separators in order to limit the amount of contaminants to the minimum. The raw materials that reach the elevator chamber are often mixed with each other in order to achieve best level of quality and then it is moved to the mill (Jankiewicz M. 2009, Jurga R. 2009).

Before moving the grain to milling chambers, it is again tested in a laboratory in order to ensure that none of the parameters decline from the standard adopted. Then the grain is moved to the production line. Nowadays, the equipment used in the flour milling processes is very effective, which substantially facilitates supervision of the whole technological process. High quality of machines improves quality and safety of finished products (Ingaldi M., Jagusiak-Kociak M. 2013, Ingaldi M. 2013).

Production of baking flours and special flours necessitates using high-performance flour mixing facilities which are capable of operation in a continuous mode. Application of such technological solutions allows for obtaining a stable and uniform mixture which matches the expectations of the most demanding customers (Gąsiorowski H. 2004).

Apart from different types of flours, a mill is also capable of producing semolina through a set of specialized fanning mills where, a product with rare purity can be obtained and it can be ensured that a maximum content of ash should not be greater than 40%. Low content of mineral substances is obtained through a very precise separation of the part of grain covers, termed specks (Jankiewicz M. 2009, Jurga R. 2009).

The basic process of production of ordinary baking flours allows for obtaining T500 and T750 flours, semolina and bran. The option of mixing the passage flours allows for obtaining lighter or darker grades of flours. This procedure ensures the products with very fine or thicker grain
Depending on the parameters and types, the flour produced is classified and moved to dedicated chambers. A simplified diagram of wheat milling is presented in Figure 3.1 (Gąsiorowski H. 2004).

Depending on customer expectations, the finished product is sent in a loose form in dedicated semi-trailers or in sacks or packed into unit bags. The process of packaging uses modern machines which, at the last stage, are adapted to mark production batches with barcodes. Packaged, the finished product is stored in a warehouse.

During production and packaging of the finished product, the flour is classified according to its parameters. Some of them are produced based on Polish standards while others are based on company standards or customer quality specifications. The customers have often their own individual requirements of the product quality and they inspect parameters provided in specifications (Gąsiorowski H. 2004).

Before flour is sent to the customer, the basic parameters are evaluated, including humidity, gluten content, falling number, ashes and protein content and rheological tests. These include in particular farinograph tests which is aimed at measurement of water absorption, dough growth.
time, its stability and softening. This analysis is aimed at determination of the behaviour of the dough made from a specific flour during production process in a bakery. Additional tests can be carried out using extensograph, which helps determine energy, extensibility and maximum resistance of the dough and consequently, assess how the dough will behave during dough proofing.

It should be noted that the most objective test for the dough is test baking. This method evaluates maximum time that the dough resists during the process of dough proofing in order to achieve the maximum growth.

Contemporary mills use the principle which says that only the grain which meets all the parameters can reach the production and therefore, only the flour that meets particular standards and specifications can be sent to a customer (JANKIEWICZ M. 2009, JURGA R. 2009).

3.2. Characterization of production specificity of the enterprise

The enterprise has its headquarters in the Greater Poland region. The location is excellent due to the neighbouring agricultural areas. It, in order to meet high quality expectations of the customers, imports grains with specific parameters which in Poland are impossible to be achieved. Combined with modern equipment, using high-quality raw materials in a manufacturing cycle guarantees a very high quality in production of special flours for industrial customers, standard baking flours and packaged flours in the retail market.

It has focused on production of niche flours i.e. flours dedicated individually for a specific type of products. These types of flour make the work of bakers or confectioners easier and limit or even eliminate the need for using other ingredients. Each type of special flour is made from special mixtures of grains so that the flour meets, at next stages, particular requirements defined by customers. Each product necessitates a special manufacturing process and is subjected to individual supervision in the laboratory. Furthermore, customers often require a specific way of
packaging and means of transport (own study based on the materials from the enterprise).

3.3. Study aim

The main aim of the study is to provide a preliminary feasibility analysis for implementation of the **Fail Assessment Method - Flour Mixture Choosing (FAM-FMC)** system as an additional tool to support production of flour with desired parameters by the customer in the enterprise studied. In order to perform the research task, the study used the following research methods: observation, induction, descriptive method, free interview.

3.4. Description of the system in the enterprise

Each process of accepting raw materials, flour production and packaging of the finished product, order processing and all the laboratory tests performed must be documented. Until recently, several independent pieces of software have been used for documentation, which significantly limited flow of information between individual departments. In order to track all the processes that are performed in the enterprise, it decided to implement one compatible software which ensures trouble-free data exchange between the organizational units in the enterprise.

This allows for quick verification of inventory levels, acceptance of grain supplies, orders placed and processing orders in a specific period of time. The documentation of finished goods must also be recorded.

Software for recording and monitoring of all the processes in the enterprise was implemented in the enterprise. The software is dedicated to the needs and requirements of the enterprise. It integrates all the elements of the organizational structure of the mill. If the recording of a specific process is neglected, the next processes following this process are automatically locked.

The software features an option for tracking the supply chain with contracts signed with bigger grain manufacturers. This allows for im-
proved organization of the deliveries of raw material through notification per each vehicle for a specific day and hour of acceptance. Each grain delivery is assigned the results of tests performed in the laboratory and, based on them, the grain is classified and assigned to a specific group of raw material stored in a particular chamber. This prevents errors that result in deterioration of grain quality due to mixing grains with different parameters.

The software also allows for graphical representation of the layout of the chambers in the elevator and the mill with goods stored in individual chambers and labels assigned. This helps verify the status of the raw material present in chambers and the level of filling a particular chamber with respect to its overall capacity. The elevator employees have a computer stand with suitable equipment, where only the deliveries which have been tested and accepted by the laboratory are displayed. Documents are generated automatically for each operation. In this case, the system generates elevator acceptance documents. Each test must be recorded in order to be later viewed in the laboratory reports.

After acceptance of the grain to elevator, the system moves on to recording of the following operations (own study based on the materials from the enterprise):

- **Mixing order or inter-chamber transfer order** The grain is usually mixed or transferred in the chambers. The elevator manager issues a transfer/mixing order. This is the signal for the employees to perform specific tasks. The order defines the name of an employee who should process the order, the chambers where the tasks are expected to be performed and the amount of grain which should be mixed or transferred. Each step is recorded.

- **Grain release to mill order** Before the grain is sent to the mill, it should be prepared for production of a particular type of flour. Therefore, it should be verified if the grain present on the elevator meets the specific standards. The finished raw material is transferred from elevator chambers to pre-production chambers. This operation is confirmed by the order of grain release from elevator.
The order to release grain to production chambers is connected with generation of a specific document. The grain is soaked and matured at this stage. All the parameters are constantly monitored and can be previewed in the software.

**Production order.** In this operation, apart from basic data, the order should also contain the quantity of grain necessary for a specific production, types of flour to be made and chambers to which it is going to be transported. The task of a miller is to process the order and read from the scales under the chambers which quantities of flour have been produced. Similar to grain chambers, each movement that increases or decreases levels on the chambers is recorded. Each document allows for preview of component documents.

**Flour mixing order** is placed in order to obtain the flour with specific parameter and to transfer flour to the chambers from which it is directly packaged.

**Packaging order** for the finished product and preparation of the product for shipment to the customer is the last stage of the production process. Each batch of flour is packaged according to specifications. This might be general specifications used for the most of the customers or specifications for a particular customer. While processing the packaging order, the warehouse workers have to input the initial and final batch number which is assigned to a specific quantity. The flour arrives with automatically generated document which provides information about levels in the warehouse of finished goods. The information is added about the packaging specifications for the flour batch. During loading of the finished product the forklift operator inputs all the pallets loaded on the vehicle into the computer system through a loading panel. Further, a document is generated.

It should also be noted that the software also represents the source of important information concerning suppliers, customers and employees. The system contains personal data, contacts and the history of cooperation with partners. The preview of test results for the samples of grains delivered is also available. Other recorded data are flour deliveries to
customers and its technological and production specifications with com-
plaints lodged by the customers about the finished products.

The data contained in the software characterize the structure of the
enterprise. It contains the description of the position of the people em-
ployed. It also contains the data about the standards used in the enterprise
and the certificates granted.

3.5. Opportunities for system implementation

Production of flour with particular parameters adjusted to individual
customer needs has become a specific market niche. Variety of consumer
preferences has forced a production of new, non-standard types of flour.
It is also essential, that the flour „tailored” to the customer needs should
show satisfactory quality parameters. Obtaining flour with parameters
desired by an individual customer is the responsibility of the mixing divi-
sion in the enterprise since this division is the place where base flours
available in the mill are mixed with specific proportions

Therefore, mixing divisions in flour mills should be equipped in
a system to support mixing process. The system should feature flexible
programming, option of graphical presentation of the data and recording
the data so that the flour is made according to the recipes specified by

Therefore, the problem of mixing the flour involves development of
an efficient method to ensure that the flour produced meets various pa-
rameters expected by different customers. In order to achieve this goal,
a computer system FAM-FMC was developed. The FAM method is used
for assessment and evaluation of components of flours and their mixtures.
The assessment concerns both objects, such as flours available and con-
structions of objects during generation and empirical production.

FAM-FMC system is a user-friendly tool to support production of
flours which can be described through the following components:

Main menu performs all the system functions. The letters on the right
mean flour parameters (A - humidity, B - gluten content, C - gluten in-
dex, D - falling number, E - ash content, F - protein content) used by the system to perform computations. Main menu in the program is presented in Figure 3.2.

![Fig. 3.2. Main menu in the program.](source: own study)

The main menu offers the choice of program blocks. The most important blocks include:

- Preview and edition of the data,
- Mixture of two flours,
- Mixture of three flours,
- Mixture of four flours.

The choice of a specific action in the system is made by highlighting the action with cursor buttons and pressing ENTER.

Preview and edition of the data is used for inputting and previewing of the parameter values. Lines 1 to 9 contain parameters of flours available in the mill. The parameters of the flour searched are presented in the last line, marked as 0. It is impossible to change the flour name – last column. When edition is completed, pressing the ESC button switches the system back to the system menu. An example of preview and edition screen is presented in Figure 3.3.
Fig. 3.3. Example preview and edition of the program data.
Source: own study

Two flours mixture is the block used for generation of all possible combinations for two of nine flours in all the possible ratio variants (Fig. 3.4). Only previously selected parameters are used for computation (presented in the menu screen).

The values of parameters obtained for the theoretical flour are displayed each time. Next, the differences for individual parameters are calculated i.e. how the values for searched and theoretical flour are different. At the final stage, the system displays 8 combinations and variances of ratios for which the theoretical flour is the most similar to the searched flour i.e. it has the lowest sum of percentage square of differences between the values of parameters.

Fig. 3.4. Eight combinations of two initial flours which are most similar to the parameters of the flour searched.
Source: own study
Three flours mixture. The block is used for generation of all possible combinations of three flours in all possible ratios. It operates analogously to the case of two flours, which is presented in Fig. 3.5.

Fig. 3.5. Eight combinations of three initial flours which are most similar to the parameters of the flour searched.

Source: own study

The components of FAM-FMC system presented in Figs. 3.2 to 3.5 demonstrate its usefulness for the production process in the enterprise studied. It might supplement the software already implemented. The opportunities for the use of FAM-FMC system for ordering flour mixing seems to be particularly interesting since it shortened the duration of this operation while reaching the expected result.

3.6. Conclusions

In conclusion, the study demonstrated that FAM-FMC system can be successfully used as a supplement for the implemented program since:

a) The speed of system operation is equal to the speed of decision concerning the choice of proper flours being the components of the special flour mixtures.
b) The program is capable of analysis of six parameters (humidity, gluten content, gluten index, falling number, ash content, protein content) in composition of flours, which represents a significant improvement since only two parameters were analysed so far.

c) The program enables the choice of parameters in case of a failure of the laboratory equipment.

d) It is possible to obtain many mixtures of special flours with the highest quality specified by the customer.

e) It is also possible to use the flour which has not been used for other purposes and remains present in the enterprise as stock in the warehouse.

References


