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POSSIBILITIES OF UTILIZATION OF LEFTOVER BREAD

Food production is a top priority issue, as the lack of food for the continuously growing population is becoming an increasing problem in the world and in Serbia as well. Increase of food production for humans and animals can be achieved by use of new technologies in biotechnology, i.e. in bioindustry. Nowadays, there are many different ways for thermal processing of cereals: toasting, extrusion, hydrothermal processing, micronization, microwave treatment, while in Serbia, the most frequently used processes are extrusion and hydrothermal processing. The baking industry is highly developed in Serbia. Bread consumption per capita in Serbia is far above average consumption in the EU. According to the survey conducted, there is a significant amount of leftover bread in Serbia. Leftover bread represents an environmental problem, but also a potentially valuable raw material for human food and animal feed.

Key words: leftover bread, quality food, environmental protection.

Bread is the most frequent product made of grains and also a basic food in many countries. It is made by mixing flour and water and certain secondary materials, which after fermentation, shaping and baking gives the final product. After being taken out of the oven, loaves have to be cooled down, and over time they become drier and their quality changes [1].

One of the habits of the population in Serbia is to discard bread which is not consumed in one single day. This raises the question of quantity and quality of leftover bread and its safety for further use. The baking industry is characterized with a variety of different products that find their place on the market daily. Their quality estimate all possible generations of consumers. Stable quality of production, from a long-term point of view, is not easy to preserve. Positions on the market are hard to gain, but very easy to lose. In the case of sensitive production such as in the baking industry, in order to keep the existing positions, it is inevitable to make all possible efforts to keep the achieved levels of competence. Competence is commonly expressed over three basic factors: the quality, the time and the price. These factors commonly represent basic main criteria that determine the consumer's preferences for definite products [1].

Nevertheless, consumers that are accustomed to the conventional flavors, with an already formed quality criteria of their own, and are unable even to recognize distinctive sorts of bread, or to give judgment about their quality, represent the interested customers of this industry, which are really not easy to satisfy. Not educated with respect to quality, consumers very often do not know what they really seek. But, the indicative fact, which is generally accepted, is that on the market one can meet distinctive oscillations of the product quality. The goal of this work is to indicate the possible methods of estimation of product quality, whose choice could assure the demanded quality of baking industry products for long periods of time.

Organizations wishing to implement a quality management system should identify the processes necessary to really implement the system, to establish and to understand the interactions between these processes, to document in detail each process to ensure efficient functioning and control. It is process analysis that should lead to establishing the documents necessary for a quality management system and not the documents.

Quality control aims at assessing product quality requirements, focusing on a distinct objective, "ensuring quality". Everything needs to be well documented and observe the rule "Write what you need to do and do what you have written down!" Quality management system is a modern system of managing quality involving the entire personnel. One of the main principles of a standard is involving more in quality issues by establishing one's own policy in the field of quality

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and goals to reach. Data resulted from quality management systems are used in a management analysis aimed at assessing the way goals have been reached and at designing new goals to reach, together with the need to continually improve the quality of processes and products. At present, investment in quality is, for the operators in the milling and panification industry, a safe way to increase unit competitiveness, to reduce costs and, implicitly, to sell cheaper, hence consumer fidelity and new niche markets [2].

Designing and implementing a quality management system differs from one organization to another, depending on size, structure, type of products, type of processes, goals, etc. Therefore, it is imperative that operators know the legislation in the field, have a trained personnel, and cooperate only with accredited certification societies when they need to certify the system. A well functioning organization needs to be operated and controlled systematically and transparently, which can be done by implementing and maintaining a management system designed to continuously improve performances, including quality management. High management should observe the following eight principles: operating a customer oriented organization, leadership, involving personnel, process-based approach, approaching the management as a system, continuously improving, efficiency in decision making, mutually advantageous relationships between the organization and suppliers. A quality management system should rely on the following requirements:

- general requirements:
 - establish a quality management system;
 - documenting a quality management system;
 - maintaining a quality management system;
- documentation requirements:
 - documented policy statement;
 - editing a quality manual;
 - documented procedures required by the standard;

• documents necessary to ensure planning, operating, process control, and records control efficacy.

According to SR EN ISO 9001:2001, the elements of a quality management system can be ranged in four domains:

- management responsibility;
- resource management;
- product manufacture;
- product measurement, analysis, and improvement.

MATERIAL AND METHODS

The survey was conducted through questionnaires and interviews of consumers, small bakeries,

large industrial bakeries, large retail chains, restaurants, city utility companies in the territory of Vojvodina. The research was conducted in the period from January to March 2010 by the Institute of Food Technology in Novi Sad (FINS). Statistical and computer processing of survey data was done using the software package "SMARTLINE", Novi Sad.

In order to avoid loss of information, finding the finest links and information on non-parametric sizes, scaling of the data in contingency tables was applied. This process is based on frequency, so each class was assigned with the real number. Statistical analysis included multi-analysis of variance (MANOVA), discriminative analysis, and other parametric procedures and methods. Also, Roy's test, Pearson's contingency coefficient (c), and multiple correlation coefficient (R) were calculated.

RESULTS AND DISCUSSION

There are no official statistical data on the quantities of leftover and discarded bread in Serbia, whereas in England it is about 0.1%. According to the survey carried out in January-March 2010 by the Institute for Food Technology in Novi Sad (FINS), the amount of leftover bread in Serbia ranges from 5-10% of the produced quantity. Based on earlier research in FINS, chemical composition of different types of bread and bakery products is shown in Table 1. Key factors for the quality (attributes influencing the quality) of bakery products, according to the attitudes of consumers, are:

- Raw materials quality,
- technology,
- sanitation and
- baker's knowledge and experiences.

It was found that from one million of 0.5 kg loaves produced in Vojvodina, a minimum of 50,000 loaves are discarded, which makes a total of 25 t of bread per day. From safe leftover bread, *i.e.* without the presence of harmful substances, a very attractive raw material can be obtained, and from unsafe leftover bread major health and environmental problems can occur. Mycotoxins from unsafe leftover bread pose a serious health threat for the part of population who collect food from street dustbins. A significant amount of leftover bread comes from:

Households (it is thrown away together with other waste or in separate bags); Bread is 1-5 days stale and of problematic microbiological safety.

Large bakeries - undelivered products or products returned from supermarkets.

Table 1. Chemical composition of different types of bread [3]

Product type	Flour		Chemical composition %						Bruto calories per 100 g product
	Rye	Wheat	Water	Proteins	Fat	Carbohydrates	Cellulose	Ash	
Rye bread	Whole grain	-	45.5	5.9	1.1	44.5	1.0	2.0	217
Pan bread	refined	-	42.0	6.2	0.8	49.0	0.5	1.6	233
Heart bread									
Wheat bread	-	Wholegrain	43.1	7.0	1.6	45.1	1.2	2.0	228
Loaf	-	Dark	35.8	9.0	1.3	51.4	0.7	1.8	260
Bun	-	Semiwhite	31.7	9.4	2.0	55.1	0.2	1.6	283
Fatly baked Ware		White	35.0	7.6	5.5	50.7	0.2	1.0	290
Toast rye	Wholegrain	-	11.0	11.4	1.4	70.6	1.9	3.7	349
butter	-	White	11.0	9.5	5.5	72.3	0.2	1.5	387
	-	Semi-white	17.0	10.6	1.2	69.0	0.2	2.0	338

City dumps where large quantities of bread ends up mixed with and contaminated by other waste.

Small bakeries quite rationally and economically organize their production. Leftover bread is not a problem for them according to the survey carried out with small bakeries.

Consumers described the importance of bread for nourishment with the following attributes:

- Main food 10.26%,
- important 45.06%,
- very important 25.64%,
- less important 13.92%, and
- negligible 4.40%.

It is clear that 81.68% of the polled population consider bread as being very important in the nourishment, and only 18.32% of population do not consider it as food of special importance. The rankings of factors that have effects on decision about purchasing of the product, consumers priorities were as follows:

1. product quality,
2. product freshness,
3. regular supplying,
4. price,
5. assortment,
6. kindness of salesmen,
7. personal liability,
8. packaging,
9. good marketing and
10. recommendation of a friend.

The basic requirement is to manufacture safe fresh bread, to make sure that leftover bread is harmless as a raw material for further processing. Special attention should be given to good hygiene practice, which is anyway compulsory for bakers. Implementation of HACCP improves the situation on the market, as those who do not fulfil hygienic requirements will not be allowed to manufacture, whereas those

who do will have regular quarterly checkups. Leftover bread can be used, under the condition that it is hygienically fit, as animal feed, bio energy fuel, as well as in bio fermentative processes for biogas production. Expired bread, which does not have micotoxines, metabolites of moulds, can be processed by extrusion and then used as a protein-energy ingredient in animal feed for, *e.g.* fish and pets.

Possibility of leftover bread further processing and its re-use as proposed by the authors for this paper is shown in Figure 1.

Recommendations for physical-chemical, microbiological, and toxicological analysis of raw materials, half-products and final products.

In relation to leftover bread valorisation in feed processing in biobrick production, the following parameters should be analysed:

- chemical analysis of raws and old bread: basic chemical composition, starch content, total and reducing sugars content, heavy metals content (lead, cadmium, mercury and arsenic),
 - physical characteristics: test weight, slip angle
- microbiological and toxicological analysis according to [4] and
- energy value (calorimetric bomb).

Quality analysis of final products of leftover bread processing

Quality analysis should be done on bricks and animal feed by following parameters:

- Bricks: moisture content, test weight, total energy value (calometric bomb);
- human food and animal feed: basic chemical composition, starch content, total and reducing sugars content, heavy metals content (lead, cadmium, mercury and arsenic);

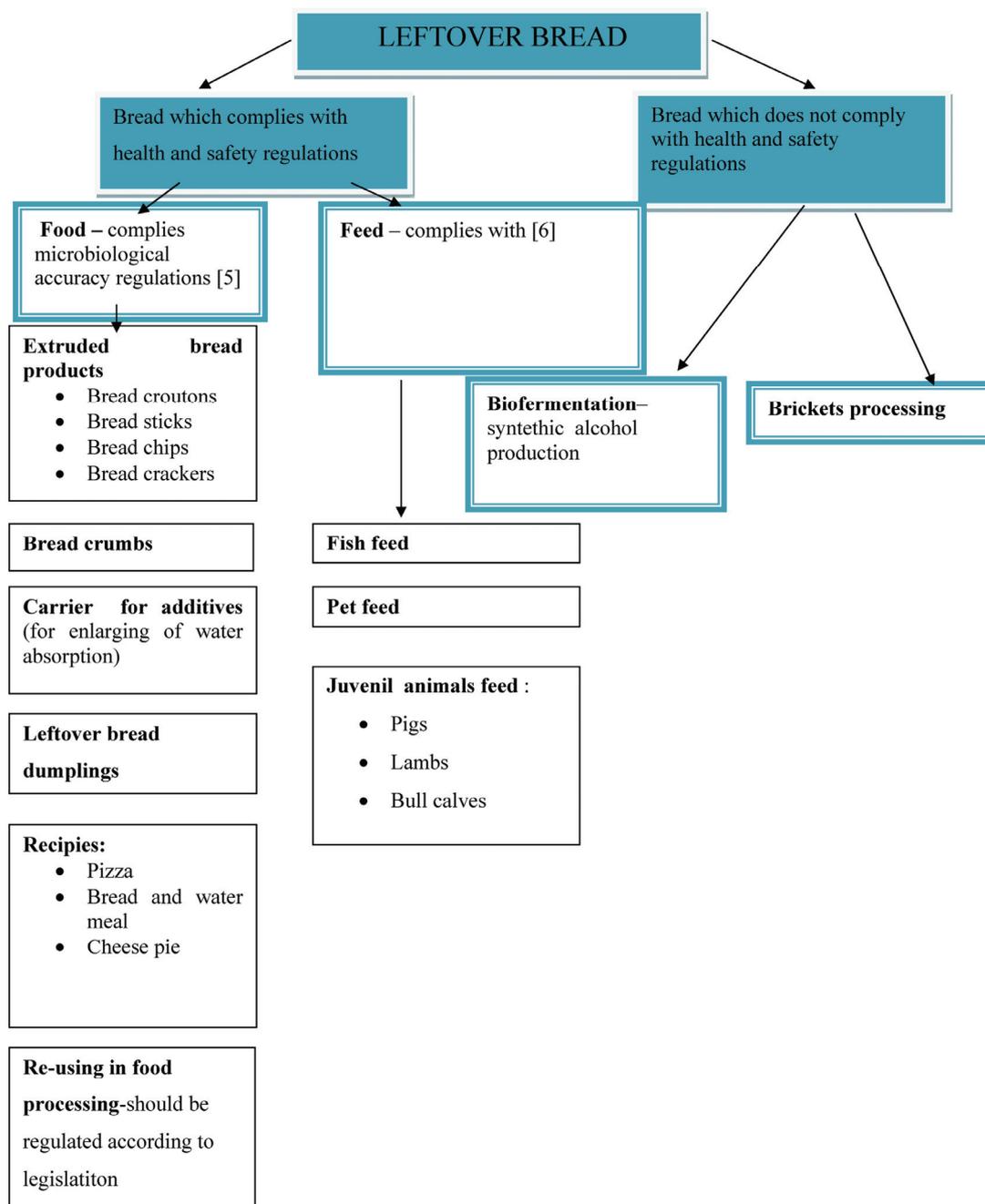


Figure 1. Possibility of further leftover bread processing and its reuse.

- Physical characteristics: test weight, slip angle
microbiological and toxicological analysis according to [4];

- energy value (calorimetric bomb).

Leftover bread and by-products of storage and primary production

After rough cleaning, rapeseed oil contains a certain percentage of cellulose that can be mixed with the old moldy bread, and then the briquetted and pelleted. Ingredients of crude sunflower cleaning (with

aspirator): sunflower hulls, sunflower heads and parts of the plant, contain a certain percentage of oil and cellulose and can also be mixed with the old moldy bread, and then the briquetted and pelleted. Processing of grain (corn, wheat, barley, oats, triticale, etc.), after cleaning and drying the aspirators if necessary, obtain the following: harsh ingredients that make up the chaff, straw, plant parts, seeds and other weeds. After cleaning, these coarse grain ingredients can as well be mixed with the old moldy bread, and then the briquetted and pelleted. This way, the old

bread processing technology can be solved by the process of briquetting and pelleting by-products from primary agricultural production. If the old bread meets the nutritional regulation of the quality of food for animals [7] one can use the extrusion process combined with a certain ratio of "fine" impurities from primary agricultural production to obtain energy protein feed intended for animal nutrition, or otherwise to obtain fuel, *i.e.* energy.

CONCLUSION

Technological proposals for the implementation of practical solutions of leftover bread reuse are given by the team of researchers (FINS) that has extensive practical experience in industrial conditions in the food and feed production, designs of technological procedures for pelleting and extrusion, mill and bakery plant design, as well as solving the problem of effluents in the mass production of food.

There is a significant amount of leftover bread in Serbia, which represents an important ecological, health and safety issue. There is no organized way of leftover bread collection and distribution for possible further processing. As a result, there is an evident increase in environment pollution and related problems in the food chain.

Large amounts of impurities in the processing of cereals, soybean, sunflower, field pea, and using effluents from other biotechnologies can give very valuable nutritional products. Our food industry is a major generator of waste, and reuse of leftover bread is a way to overcome ecological problems.

REFERENCES

- [1] A. Marić, S. Arsovski, J. Mastilović: Contribution to the improvement of products quality in baking industry, 3rd ICQM Proceedings, Kragujevac, 2009, 21-28.
- [2] FAO/WHO Consultation on the Health Implications of Acryl amide in Food, Geneva, 2002, Summary report.
- [3] Z. Nježić, Đ. Psodorov, J. Živković, D. Palić, B. Cvetković: Possibility of Using Leftover Bread as Safe and Quality High-quality Food and Feed, 4th ICQM Proceedings, Kragujevac, 2010, 165-169.
- [4] Pravilnik o količinama pesticide, metala i metaloida i drugih otrovnih supstancija, hemioterapeutika, anabolika i drugih supstancija koje se mogu nalaziti u namirnicama, ("Sl. List SRJ", br. 5/92, 11/92 i 32/2002).
- [5] Pravilnik o mikrobiološkoj ispravnosti namirnica u prometu ("Sl. List SRJ", br. 26/93, 53/95 i 46/2002).
- [6] Pravilnik o maksimalnim količinama sastojaka u stočnoj hrani (službeni list SFRJ br 2/90 i 27/90).
- [7] Pravilnik o mikrobiološkoj ispravnosti namirnica u prometu (Sl. list SRJ br. 2693, 5395 i 4602).

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STRUČNI RAD

MOGUĆNOSTI KORIŠĆENJA STAROG HLEBA

Proizvodnja hrane je prioritet za čovečanstvo, jer nedostatak hrane za stalno rastuću populaciju ljudi postaje sve veći problem u svetu pa i u Srbiji. Povećanje proizvodnje hrane za ljude i hrane za životinje može se postići korišćenjem novih tehnologija u biotehnologiji, odnosno u bioindustriji. Danas postoji mnogo različitih načina termičke obrade žitarica: tostiranje, ekstruzija, hidrotermalna obrada, mikronizacija, mikrotalasi, dok se u Srbiji najčešće koriste procesi ekstrudiranja i hidrotermalne obrade. Pekarska industrija je veoma razvijena u Srbiji. Potrošnja hleba po stanovniku u Srbiji je daleko iznad prosečne potrošnje u EU. Prema istraživanju, postoji značajna količina zaostalog hleba u Srbiji. Stari hleb predstavlja ekološki problem, ali je i potencijalno vredna sirovina za ljudsku ishranu i hranu za životinje.

Ključne reči: stari hleb; kvalitet hrane; zaštita životne sredine.