Bulletin of the *Transilvania* University of Braşov
Series II: Forestry • Wood Industry • Agricultural Food Engineering • Vol. 13(62) No. 2 – 2020
https://doi.org/10.31926/but.fwiafe.2020.13.62.2.9

A NEW METHODOLOGY FOR IMPROVING THE QUALITY OF CRANBERRY BREAD

Adriana E. BOERIU[1] Cristina M. CANJA[1]

Abstract: *The Evolutionary Operation Method (EVOP) represents a method that consists in improving the productivity and energy consumption of a technological process. By improving these parameters, product properties are significantly improved. The aim of the current paper was to develop a baking process technique of bread with a 10% addition of cranberry, by varying time and temperature. Moisture and porosity were studied as quality indicators, with superior results as compared to the current working version. It was observed that for baking at 180°C for 45 minutes the results were better than for the plain sample, the energy required being diminished, moisture and porosity improved.*

Key words: *Evolutionary Operation, bread making, cranberry, properties.*

1. Introduction

The Evolutionary Operation Method, abbreviated EVOP, represents a topical method applied for optimizing the industrial processes. It was developed in the 1950s by George E.P. Box [1, 2].

Taking into account the foreseen energetic crisis that is speculated nowadays in several industries, the EVOP method is an alternative that can contribute to significantly diminish the amount of energy used for technological processes.

The technique requires experimental procedures and process improvements in order to provide satisfactory results and diminish the amount of energy required for process development.

The EVOP statement is to focus on systematic experimentation of several parameters in order to accomplish adaptive optimization of industrial technological processes. The experimentation procedure is relatively simple and efficient, considering multiple possibilities for industrial appliance and allowing continuous improvement of the technological performances of the equipment. The method consists of systematic changes of technological parameters, with lower values, as compared to the standard working conditions, each stage being succeeded by analyses of the results by using dispersion analysis [3, 4].

[1] Department of Engineering and Management in Food and Tourism, *Transilvania* University of Brasov, Castle Street no. 148, Brasov 500014, Romania;
Correspondence: Cristina M. Canja; e-mail: canja.c@unitbv.ro.

The slight variations found in the technological parameters does not affect the normal development of the process, instead they represent accepted tolerance.

The value of variations is usually low, creating in some situations several difficulties in assessing their effects, since their effects can be compensated with the significant effects of the random variations of the process [3].

The experimentation approach is similar to the factorial plans, but instead variation intervals of factors are decreased [4].

The calculation of the parameters consists of estimating the effects and confidence intervals. The main attribute of this method is that it does not use a mathematical method in neither of the phases [2], [6, 7].

Taking into account the main attributes of the method, the EVOP method can be applied also in bread making industry. Frequently, the industry faces problems concerning energy consumption, the claimed operations being baking, the industrial ovens consuming a higher amount of energy, in comparison to other equipment used.

Cranberry represents an important source of antioxidants and fibre that promotes a healthy support for a balanced lifestyle [5]. Bread is one of the most widely consumed products, representing the choice of a large number of consumers due to its nutritional properties. Cranberry bread is a novel product, designed for fulfilling the needs of the actual consumer – taste and benefits, due to the potential of cranberries.

The aim of the current paper was to create a baking process procedure using the EVOP method, taking into account the variation of baking time and temperature associated in different working variants and to determine a series of physicochemical parameters – i.e. porosity and moisture for the samples.

2. Materials and Methods

The samples for the experimental research were obtained using the following ingredients: 500g wheat flour type 650, harvest 2013, milled at a local mill near Brasov county, 50g fresh cranberries, 300 ml of water, 25 g fresh yeast, 10g sugar, 10 g salt and 50 ml of sunflower oil.

The bread was obtained using the straight dough method of preparation. All the ingredients were prepared, dosed and mixed at the speed of 250 rpm for 15 minutes in a laboratory mixer (Tefal Wizzo, China) until a homogenous consistency and a flexible mass was obtained. Then, the dough was divided into pieces of 60 grams, modelled in round shape as bread buns and placed in stainless steel trays.

For weighting the raw and auxiliary materials, the Radwag precision balance was used, with a precision of 0.01 g.

Considering the current process - namely obtaining a plain sample with no addition of cranberry, the working parameters were: baking time of 45 min., and a temperature of 220^{o}C.

In the process of bread baking with an addition of 10% cranberry, two factors were studies – i.e. time and temperature, due to their importance and adjustment possibilities according to the process requirements. Two qualitative aspects were monitored: core moisture and porosity, attributes that can be easily measured during study.

Then, for the analysed baking process

(Figure 1), the EVOP process was applied. The working procedure for baking bread with an addition of 10% cranberry is revealed in Table 1.

Table 1

Working procedure in the process of baking white bread improved with an addition of 10% cranberry

Variant	Factor A (baking time, min.)	Factor B (temperature, °C)
1	45	180
2	35	200
3	40	220

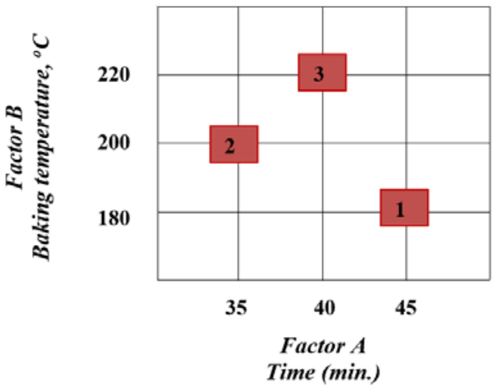

Fig. 1. *EVOP procedure*

By associating factor A with factor B, the following working options were obtained:

- 45 minutes at 180°C;
- 35 minutes at 200°C;
- 40 minutes at 220°C.

During the study, two series of five charges of each variant were performed, simultaneously monitoring moisture and porosity (Figure 2).

3. Results and Discussions

Core moisture was recorded in Table 2, also worth mentioning is that the previous evaluation of the deviation had been evaluated until the start of the study, by considering the data resulted for the current process for the plain sample, established as being $\upsilon = 0{,}11$.

Porosity was monitored in Table 3. As for core moisture, the previous evaluation of the deviation had been established by means of data obtained for the process of the plain sample and was established as $\upsilon = 0{,}32$.

Fig. 2. *Baking samples*

Table 2

The EVOP method with two variables

Step 1: Purpose: Improving core moisture **Cycle n=1** (10% cranberries)							
No.	**Average**						**Deviation**
Working variant		**1**	**2**	**3**	**4**	**5**	
I	**Data of the previous cycle**	-	-	-	-	-	Previous value of s = -
II	**Average of the previous cycle**	-	-	-	-	-	Previous average of s = -
III	**New observations**	44	43.7	42.9	43.8	44.1	„s” new = amplitude X f_{5n} = 44.1
IV	**Differences II - III**	-	-	-	-	-	Amplitude = -
V	**New sum**	44	43.7	42.9	43.8	44.1	New sum of s = 218.5
VI	**New average**	44	43.7	42.9	43.8	44.1	New average of s = 43.7

Effects calcuation	**Calculation of the limit errors**
Effect of factor A (time) = = 1/2 (y_3+y_4-y_2-y_5) = = 1/2 (42.9+43.8-43.7-44.1) = - 0,55	For new average $\pm\frac{2}{\sqrt{n}}\cdot s = \pm 0{,}22$
Effect of factor B (temperature) = = 1/2 (y_3+y_5-y_2-y_4) = = 1/2 (42.9+44.1-43.7-43.8) = - 0,25	For new effects $\pm\frac{2}{\sqrt{n}}\cdot s = \pm 0{,}22$
Effect of both factors (A x B) (time x temperature) = 1/2 (y_2+y_3-y_4-y_5) = = - 0,65	For changing the average: $\pm\frac{1{,}79}{\sqrt{n}}\cdot s = \pm 0{,}20$
Effect of changing the average = = 1/5 (y_2+y_3+y_4+y_5-4y_1) = -0,30	Previous evaluation of υ = 0,11

After finishing the two cycles, when core moisture and porosity had been simultaneously analysed, the experimental part stopped. This stoppage was determined by the constantly superior results obtained for one of the working variants.

The study conducted a series of new values for effects, errors and deviations, revealed in Tables 4 and 5.

The EVOP method with two variables Table 3

Step 1: Purpose: Improving porosity **Cycle n=**1 (10% cranberries)							
No.	**Average**						**Deviation**
Working variant		**1**	**2**	**3**	**4**	**5**	
I	**Data of the previous cycle**	-	-	-	-	-	Previous value of s = -
II	**Average of the previous cycle**	-	-	-	-	-	Previous average of s = -
III	**New observation**	72	73,6	70	72	74	„s” new = amplitude X f_{5n} = 74
IV	**Differences II - III**	-	-	-	-	-	Amplitude = -
V	**New sum**	72	73,6	70	72	74	New sum of s = 361.6
VI	**New average**	72	73,6	70	72	74	New average of s = 72.32

Effects calculation	Calculation of the limit error
Effect of factor A (time) = 1/2 ($y_3+y_4-y_2-y_5$) = = 1/2 (70+72-73,6-74) = - 2,8	For new average $\pm\frac{2}{\sqrt{n}}\cdot s = \pm 0{,}64$
Effect of factor B (temperature) = = 1/2 ($y_3+y_5-y_2-y_4$) = = 1/2 (70+74-73,6-72) = - 0,8	For new effects $\pm\frac{2}{\sqrt{n}}\cdot s = \pm 0{,}64$
Effect of factors (A x B) (time x temperature) = = 1/2 ($y_2+y_3-y_4-y_5$) = = - 1,2	For changing the evaluation: $\pm\frac{1{,}79}{\sqrt{n}}\cdot s = \pm 0{,}57$
Efect of changing the average = = 1/5 ($y_2+y_3+y_4+y_5-4y_1$) = 0,32	Previous evaluation of υ = 0,11

Effects, errors and deviations Table 4

Effects	moisture	porosity
Factor A (time)	0.050	0.200
Factor B (temperature)	-	0.450
Factor AxB (time x temp.)	-	0.200
Effect of changing average	0.040	- 0.080

Calculation of the limit error Table 5

For averages	±0.069	±0.023
For effects	±0.069	±0.230
For changing the average	±0.061	±0.200
New deviation	0.069	0.230
Previous evaluation of deviation	0.110	0.320

As it can be observed, during the study of the two parameters – core moisture and porosity for sample with a 10% addition of cranberry, superior results were obtained as compared to the current working variant. In each cycle, three of the samples, which had the most adequate results, were chosen. For the working variant with 10% cranberry, were obtained adequate values of the two parameters were obtained for the following working procedure –180°C and 45 minutes. The results obtained were compared to the values obtained for the plain sample, which was considered the current working variant. The current working variant shows suitable results, so the comparison is going to refer to the plain sample. For the plain sample, the moisture is considered to be 43.1%.

So, for the moisture determination of the current sample, the difference between the plain sample and the best result obtained for the current sample is 43.1-42.9=-0.2. By dividing 0.2 and by using new standard deviation 0.069, the value 2.89 is obtained, which indicates a significant improvement.

For porosity, the current variant is considered to be 74%, and the difference between the current variant and the most suitable result obtained is 74-73.5=0.5. By dividing 0.5 by the standard deviation considered to be 0.230, the obtained result was 2.17, thus revealing a sensitive improvement. Taking into account that for the samples with 10% cranberry adequate values were obtained for temperatures of 220°C, 200°C and 180°C for 35, 40 and 45 minutes, it was decided to pick the variant which offers most advantages concerning energy consumption, offering results as adequate as possible for treatments with higher temperatures. Also, it is necessary to analyse the advantages obtained through the improvement of the two qualitative characteristics analysed. If the advantages are appropriate, they will be introduced in the technological flow the new working parameters. A lower thermal treatment applied to cranberries prevents a decrease in antioxidant, fibre and vitamin content. Also, the degradation of the brilliant red colour which is distinctive for cranberries, due to anthocyanin pigments such as galactosides and cyanidins, is faded, the colour being preserved in the product core and crust.

4. Conclusions

The current experimental research has led to satisfactory results that offer new perspectives on analysing the EVOP method. Therefore, by acting on the temperature and time factors for the baking process followed the improvement of the characteristics: namely porosity and moisture and the losses generated during bread baking were diminished.

Products' porosity was improved, through optimizing the temperature and time factors.

By slowly modifying the factors, significant changes concerning the diminishing of the cracks of the crust and increased flour performance were observed.

The method represents an alternative that can be frequently used as a method of energy consumption optimization. Bread making industries can implement the EVOP method for improving several attributes of products, thus reducing the amount of energy resources used and maintaining product quality. The method resides in accuracy, rapidity and perpetual improvement of the process and can easily abide by the environmental requirements concerning the preservation of resources and reduce energy consumption for achieving high productivity.

References

1. Ginting E., Tambunan M.M., Syahputri K., 2018. Application study of evolutionary operation methods in optimization of process parameters for mosquito coils industry. In: IOP Conference Series: Materials Science and Engineering, vol. 309, doi:10.1088/1757899X/309/1/012031
2. Kumar S., Katiyar N., Ingle P. et al., 2011. Use of Evolutionary Operation (EVOP) factorial design technique to develop bioprocess using grease waste as a substrate for lipase production. In: Bioresource Technology, vol. 102(7), pp. 4909-4912.
3. Land S.K., Smith D.B., Walz J.W., 2008. Practical Support for Lean Six Sigma Software Process Definition: Using IEEE. John Wiley & Sons Publication.
4. Lawson J., 2010. Design and Analysis of Experiments with SAS. CRC Press LLC.
5. Mildner-Szkudlarz S., Bajerska J., Górnaś P. et al., 2016. physical and bioactive properties of muffins enriched with raspberry and cranberry pomace powder: A promising application of fruit by-products rich in biocompounds. In: Plant Foods for Human Nutrition, vol. 71, pp. 165-173.
6. Ostergaard S., Lastein D.B., Emanuelson U. et al., 2020. Feasibility of Evolutionary Operation (EVOP) as a concept for herd-specific management in commercial dairy herds. In: Livestock Science, vol. 235, 10.1016/j.livsci.2020.104004.
7. Rutten K., De Baerdemaeker J., De Ketelaere B., 2015. A comparison of Evolutionary Operation and Simplex for process improvement. In: Chemometrics and Intelligent Laboratory Systems, vol. 139, pp. 109-120.