تباينات تكنولوجية في تصنيع الخُبْزِ التموينيِّ المُسطَّح ثنائي الطبقة في سوريا

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الملخص

شكلَّت التطورات الاقتصادية والاجتماعية والتقنية في سوريا حاضنة واقعية لتهيئة الظروف المناسبة لخلق مفهوم تكنولوجي في تصنيع الخُبْز ثنائي الطبقة هو الخُبْز التمويني. تمَّ تسليط الضوء على بعض أهمِّ العوامل المَعْلَمِيَّة (البارمترية)، التي تتحكَّم في عملية تصنيع الخُبْزِ التموينيِّ المسطَّح ثنائي الطبقة، وهي: النسبة المئويّة لرطوبة العجين، ودرجة حرارة الخَبْزِ، وزمن الخَبْز، حيث تشكِّل النسبة المئويَّة لرطوبة الخبز الناتج وفقاً للمواصفات القياسية السورية أحد المعايير واجبة المراعاة والتقيّد.

جرى معالجة البيانات التكنولوجية لعشرة مخابز بمساعدة الإحصاء الرياضي، من خلال دراسة علاقة الانحدار لهذه البيانات من أجل نمذجتها في معادلاتٍ رياضيَّةٍ، مع إظهار التأثير المتبادل بين المَعْلَمَات. وُجِدَ أنَّ العلاقة بين رطوبة العجين كمتغيّر مستقلٍّ مع رطوبة الخُبْز كمتغيّرٍ تابعٍ هي من الشكل: $Y = X^{0.905}$. كما أنَّ العلاقة بين درجة حرارة الخَبْز كمتغيّر مستقلٍّ مع رطوبة الخُبْز كمتغيّرٍ تابعٍ هي من الشكل: $y = X^{0.534}$. بينما وُجِدَ أنَّ العلاقة بين زَمن الخَبز كمتغيّر مستقلٍّ مع رطوبة الخُبْز كمتغيّرٍ تابعٍ هي من الشكل:
$Y = 4.389\ X - 0.217\ X^2 + 0.003\ X^3$. ووُجِدَ أنَّ زمن الخَبْز كمتغيّر مستقلٍّ مع طول حصيرة الخَبْز المعدنيّة كمتغيّرٍ تابعٍ عبّرت عنها العلاقة $Y = 1.153\ X - 0.086\ X^2 + 0.002\ X^3$. ويرتبط طول حصيرة الخَبْز المعدنيّة كمتغيّرٍ تابعٍ مع درجة حرارة الخَبْز كمتغيّر مستقلٍّ بعلاقة من الشكل: $Y = 0.003^X$. يمكن استخدام نتائج النمذجة لاحقًا لتعديل مُدخلات عملية الخبز.

الكلمات المفتاحية: الخُبْز المُسَطَّح ثنائي الطبقة، درجة حرارة الخَبْز، زمن الخَبْز، حجرة الخَبْز، حصيرة الخَبْز المعدنية، رطوبة الخُبْز، رطوبة العجين.

Technological Variations in the Manufacture of Two-Layer Popular Flatbread in Syria

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Abstract

The economic, social and technical developments in Syria formed a realistic incubator to create the appropriate conditions to generate a technological concept in the manufacture of double-layered bread, which is popular bread. Some of the most important parameters that control the process of manufacturing the two-layer popular flatbread were highlighted, namely: the percentage of dough moisture, the baking temperature, and the baking time, where the percentage of moisture of the bread produced according to the Syrian standard specifications is one of the standards that must be observed and adhered to. The technological data of ten bakeries were processed with the help of mathematical statistics, by studying the regression relationship of this data in order to model it in mathematical equations, while showing the mutual effect between the parameters. It was found that the relationship between dough moisture as an independent variable with bread moisture as a dependent variable is of the form $Y = X^{0.905}$. Also, the relationship between baking temperature as an independent variable and bread moisture as a dependent variable is of the form $y = X^{0.534}$. While it was found that the relationship between baking time as an independent variable with bread moisture as a dependent variable is of the form $Y = 4.389\,X - 0.217\,X^2 + 0.003\,X^3$. It was found that the baking time as an independent variable with the length of the baking metal-mat belt as a dependent variable expressed by the relationship $Y = 1.153\,X - 0.086\,X^2 + 0.002\,X^3$. The length of the baking metal-mat belt as a dependent variable is associated with the baking temperature as an independent variable with a relationship of the form $Y = 0.003^X$. The modeling results can later be used to modify the baking process inputs.

Keywords: Flatbread, Baking Temperature, Baking Time, Baking Room, Baking Metal-mat Belt. Bread Moisture, Dough Moisture.

INTRODUCTION

During the sixties and seventies of the last century, Syria was subjected to economic and social developments that imposed technological changes in the production process of the two-layer flatbread, which was subsidized by the government to provide it to all classes of the people, by providing the necessary flour for all bakeries, whether publicly or privately owned. These technological changes were represented in the use of automatic or semi-automated technological lines for the production of bread, which can meet the increasing demand for this commodity. It is worth noting that the two-layer flatbread in Syria takes three forms according to the type of ingredients involved in the manufacturing process. There is popular[*] bread made of flour with an extraction rate of 80-82%, white[*] bread made of flour with an extraction rate of 68-72%, and bread made of flour mixed with wheat bran to raise the percentage of dietary fiber in it.

Baking technology was and still depends on controlling the joints and parameters of the bread manufacturing process, the main parts of which are as follows:

A- Choosing the raw material of flour and ingredients suitable for the type of bread required from the market, such as: specified for popular consuming, white bread with low extraction, low in sugar and high in fiber such as bran[*] bread .... etc., where these ingredients play an important role in the qualities of the resulting bread [1, 11]. The quality of the flour used with a percentage of ash within the flour is in the range of 0.55-0.65% for the flour that gives white bread (meaning the extraction rate is 68-72%), and it is mostly used in Syria to produce the white two-layer flatbread called syahee (touristic), and brown bread is also produced, where the

[*] In Syria it names in Arabic "Al Khoubz Al Tamouinee"

[*] In Syria it names in Arabic "Al Khoubz Al Seahee"

[*] In Syria it names in Arabic "Khoubz Al N'khaleh"

percentage of ash in flour is 0.65-0.95% (ie, with a high extraction rate of 82-95%).
Results have been reached to determine the best water absorption by flour when it gives the equivalent of 850 units of Brabender on the Farinograph device [8], and this corresponds to a water quantity equivalent to between 56-60% of the flour weight. In terms of the protein content of the flour, which is suitable for two-layer flatbread, it is between 10-12% in order to give the elasticity, flexibility, and stability required to form the loaf with the desired specifications. The dough should not shrink after the flatting process so that the thickness changes, and it should not be pasty sticking to the conveyor belts as well as the metal-mat belt in the fire chamber or others when it is carried on [2].

B - Choosing the appropriate kneader to give the mechanical energy capable of forming the appropriate dough for the type of bread. The popular bread consists of a dough that differs in its specifications, ingredients and characteristics from the dough of white bread called syahee, as well as from the dough of bran bread. The kneading process revolves around changes that correlate relatively non-linearly with regard to temperature and power variations. The dynamics of these two variables can be expected from four operating variables: mixture mass, rotor speed, flour temperature, water ratio and temperature, and return of motion.
The dough is subject to strong stretching and shearing forces, depending on the geometry of the dough mixer bowl, the power of the motor, and the speed of the rotor, as well as its rheological properties [6]. Gómez *et al.* [4] conducted tests on two types of flour FI and FII, specifically testing the changes related to the content of free sulfhydryl's (SH_F) compounds, and it was found that the structure and rheological properties of the dough are closely related to its content of free sulfhydryls of dough proteins and the

formation of sulfur bonds in the dough, and formation of disulfide bonds (SS) during flour mixing. A sharp decrease in SH_F content was observed between flour (2.43 and 1.42 μmol SH_F per gram flour as dry weight for FI and FII respectively) and dough after 8 min of mixing: the SH_F content in FI decreased by 70%, while it decreased in FII by 50%. A significant decrease in SH_F values, especially after 16 minutes of mixing, was also observed for both types of dough. The lower SH_F content of dough compared to flour indicates that the mixing process enhances SH/S-S cross-link interactions.

Skerrit *et al.* [10] studded the depolymerization of glutenin macropolymer (GMP) during dough mixing. After intensive mixing, the molecular weight of GMP is reduced and the glutenin polymers are torn apart and freed from the dough. The partial depolymerization of glutenin, with the production of molecules with a lower molecular mass, results in a lower consistency and a more viscous dough. Additional research by Codina and Mironeasa [3] shed light for the first time on the effect of different mixing speeds (80, 160 and 250 rpm) on the microstructure of the dough during the same mixing time using the fluorescence technique. Regarding the microstructure of the dough that was studied by epifluorescence light microscopy (EFLM), the images taken at different mixing speeds differed significantly. At 250 rpm, the protein network appeared to be more compact and continuous than the speed at 160 and 80 rpm. The amount of starch granules decreased somewhat in the wheat flour dough with the increase of the mixing speed.

Studying the variability of mixing speed allowed Mixolab to obtain information about dough behavior at different stages of bread making that was more comparable than that used in industrial mixers. Increasing the mixing speed of Mixolab had a significant effect on most of the tested rheological parameters. Therefore, dough development time and stability decreased, while parameters

related to protein weakening, starch gelatinization, amylolytic activity and starch gelling increased as a result of increased mechanical shear stress into the wheat flour dough resulting from the increased mixing speed. Analysis of the principal component of the aforementioned data identifies a high correlation between gluten deformation index and development time. The large number of S-S bonds formed during mixing will result in the formation of a highly entanglement gluten matrix. On the other hand, over kneading or over mixing can result in the cleavage of some disulfide bonds with the corresponding increase in free sulfhydryls.
Skerrit *et al* [10] notified the cleavage of disulfide bonds in HMW high-molecular-weight glutenins during excessive mixing and dough breakdown. After the kneading process is completed, the dough is left for about one hour to ferment, and this time is related to the temperature prevailing in summer or winter [2].

C- The dividing machine that forms dough ball or discs (of a specific size and weight most generally between 60-150 grams), and it varies in its formation technology and the way it pushes the formed pieces out, either spirally or by pressing.

D- Choosing the flatting machine and its working principle. A dough mass may be rolled on a moving belt by passing it compressed between two levels separated by a specific adjustable distance, so that the parchment is allowed to remain in a continuous form so it remains 1.5 meters wide and 0.5 cm thick, and then exposes it to a rotating cylinder that is made through shapes engraved with specific protrusions on it by cutting circular shapes of a diameter suitable for the loaf. Or it is processed by taking dough discs of a specific mass and inserting them between two cylinders that are spaced at a certain distance and that rotate in harmony in opposite directions, thus giving a longitudinal sheet that contradicts another of two other cylinders less than the distance between them, thus, a circular shape of the loaf is obtained (the diameter of the loaf is according to the mass of the dough, and the diameter ranges between 15-40 cm) as well as giving the appropriate thickness of the loaf. The selection of the diameters of the flatted dough given by the machine is to match the rest of the subsequent technological data. The thickness of the flatted dough varies between 2-6 mm and the best results were shown by the thickness of 3 mm [7].

E- Proofing (initial and final) within the steps of producing two-layer flatbread, where it is allowed the dough mass or dough pieces after the completion of the kneading process to proof according to the design of the technological steps, before or after the dividing process, and this step is called the initial proof, which allows the flatting process to take place easily without contraction or shrinkage of the sheet and change in the required thickness of the sheet. The flatted pieces after the completion of the flatting process are also subjected to a proof process called final proof, before entering the baking process. This final proofing phase allows the dough to relax and airy, creating a thin skin.

As a result, during the baking process, especially at the high temperature of the oven, the thin skin of the dough changes to a pale-colored and stretchy crust, and the steam generated from the free water within the dough; combined with pressure from carbon dioxide and other volatiles (which develop during fermentation), to force the upper and lower crusts to separate and create two layers.

The initial proofing takes place if it is carried out before the dividing process in a basin suitable for fermentation of the dough mass, but if it is after the dividing, it is by entering the divided parts on moving belts within a room or cabin in which the humidity and temperature are appropriate. Also flatted pieces are carried on a number of moving belts within the horizontal or vertical hierarchy according to the available space, in addition to the time required for proofing. The control of the proofing-time is by adjusting the speed of movement of the belts [9].

F- The baking room or what is known as the oven, with the moving metal-mat belt carrying the flatted dough after the end of the proofing, where the time elapsed between entering and exiting the room is related to the controlling temperature within the room, and the length of the moving metal-mat belt. Karimi *et al.* [5] developed a mathematical model to simulate the performance of a semi-industrial continuous oven and indirect heating during contact baking of an Iranian flatbread. Individual modes of heat transfer were considered in the analysis to estimate oven performance, baking temperature and moisture content in terms of design and operating conditions. Good corresponding was observed between the experimental data and the model predictions. The numerical results of the studied baking system indicated that conduction is a basic heat transfer mechanism used in the baking process by providing about 87% of the required energy. The contributing heat from radiation and convection were estimated to be about 9% and 4%, respectively. Moreover, the effect of dough thickness, conveyor belt speed and intake air velocity on bread quality is well studied, and proper ranges of the parameters have been determined. It was found that the production of high quality two-layer flatbread requires a dough thickness between 2.9 and 3.3 mm, a conveyor speed between 2.9 and 3.6 cm per second, and an input air speed between 0.22 and 0.87 m per second. The water lost during baking contributes significantly to the energy consumption by this process, and reducing it is a major concern in order to conduct the process in a more sustainable manner. On the other hand, better heat transfer between the surface of the loaf (for the purpose of obtaining the desired color) and the crumb (for the purpose of spacing and puffing) in this way, along with a shorter baking time, can help increase the yield and profit [12].

G- Moving cooling belts, which receive the loaves leaving the baking room according to the time required for cooling up to the packaging or marketing process.

These main joints referred to in previous points are integrated among themselves to play Larger or smaller roles in accordance with compatibility and harmonization among themselves, and their importance in the characterization of used technology parameters, and its impact on giving the quality of the resulting loaf, as well as input and outputs of the baking room, It will be selected as a target to research on them within this scientific paper.

RESEARCH OBJECT

The popular bread commodity is produced in Syria by bakeries owned by public and private entities, and they employ different technologies, which are invested by individuals, whose competencies vary in exploiting the features that characterize these technologies to provide a commodity that the population needs on a daily basis, so that it meets the consumer’s desire for a ripe loaf that does not turn to dough again during its marketing and handling, meaning that the baking process has brought the loaf's moisture to the required level in the Syrian standard specification.

This research aims to shed light on the reality of the production of a popular bread-loaf and the correlation of the parameters of the inputs of the baking process with its outputs, and an attempt to modeling the relationship between some of the most important parameters of the inputs and outputs, by studying the regression relationship between them, and representing that with a mathematical equation, linking between an independent variable and another dependent variable, So that it is possible, through the mathematical relationship, to adjust some of these inputs, in order to adjust the required outputs.

MATERIALS AND METHODS

In order to study the variation in the inputs of the manufacturing process for the production of the two-layer flat ration bread and the characteristics of the technological process according to the variation in its data and parameters, and consequently in its outputs that characterize the resulting loaf, ten bakeries have been adopted in the city of Lattakia (which is similar to what is in the rest of the cities). Bakeries vary in ownership between the public and private sectors, as well as the availability of space that allows for a long or short design for the baking room or what is called the oven.

The following parameters were adopted to express the manufacturing process inputs: dough moisture percentage, bread moisture percentage, baking temperature Celsius degree, baking time in seconds, metal-mat length in meters. These data were obtained through field sampling from bakeries during the production period, where samples were collected from each of the resulting dough and bread taken from the ten bakeries by direct sampling from the production lines, where seven samples were drawn from each bakery at different times extending for weeks from one to the other, according to the following steps:

• Taking the length of the moving belt entering the baking room, estimated in meters.

• The diameter of the flatted dough was measured with a graduated ruler in millimeters by adopting five readings in different positions, and the arithmetic mean was taken, rounded to the nearest millimeter, and the standard deviation from the mean was calculated.

• In each sample, the fully flatted dough sheet was weighed with an accuracy of 0.1 grams. Using a small glass cup (with a circular opening with a diameter of 8 cm) as a tool for taking the dough sample after the end of the flatting process, four circles were cut from the flatted dough, while maintaining its circular shape, and the cut circular pieces were mixed with each other in the form of a dough ball, to form the dough sample The dough ball was kept in a plastic bag to prevent moisture loss until the moisture content of the dough sample was estimated. The cute dough sheet was left to enter the oven with other sheets. At the end of the baking process, the same loaf was taken as a sample of ripe bread after it reached room temperature, and it was weighted and placed in a plastic bag that prevents moisture loss to estimate its moisture percentage.

• The percentage of moisture in each of the dough and bread replicates was estimated after cutting about 10 grams from the sample with an accuracy of 0.001 grams, and drying it at a temperature of 103 ± 2° C until the weight was stable. The mean of five replicates was calculated for each sample with the standard deviation from it.

At the end of the sampling process, the arithmetic mean of the seven samples was taken with the standard deviation, so that each arithmetic mean is a value for the parameter expressed in each bakery.

Figure (1) shows the method of measuring the temperature inside the baking room

STATISTICAL PROCESSING

In order to process the data obtained in the field study, these data, whether repetitions of one sample or the seven samples taken, were arranged in a table, and the arithmetic mean and standard deviation of one sample were taken. Then the samples mean and standard deviation about it, using the well-known statistical program SPSS version 16. Then, the results were processed for mathematical modeling by choosing the independent variable and the dependent variable from among the parameter data, studying the correlation relationship, as well as exploring the existing regression relationship between the parameters to choose the best mathematical equation that represents the relationship.

RESULTS

The obtained results are classified in Table (1) according to the results of the ten bakeries, so that these results reflect the outputs of operating the technologies available in the bakery, according to the varying interest of those in charge of the outputs of the production process, for more than one reason, mainly:

- ❖ Either there is no follow-up to the specifications of the bread produced by the authorities in charge of supervising production, and therefore there is no real deterrent for violators of the required specifications, as they are based on the production process, searching for profit only.
- ❖ Or the lack of expertise of the workers operating the machines in the bakery in an optimal and efficient manner.

❖

Table (1): Data related to the moisture-percentage of the dough and bread, as well as the length of the metal-mat belt, baking-temperature and -time for ten bakeries.

Bakery	Percentage of dough moisture		Percentage of bread moisture		Flatted-bread diameter in cm		Baking temperature in centigrade	Baking-time in second	Length of the metal-mat in meters
	mean[a]	Standard deviation	mean[a]	Standard deviation	mean[a]	Standard deviation			
A	42.4	3.5	27.8	4.24	28.3	1.26	455	11	4
B	41.0	0.39	26.1	0.72	27.5	0.58	420	20	3
C	40.5	0.59	23.4	0.98	27	0.82	465	9	5
D	42.2	1.46	27.3	2.34	27.5	0.58	432	20	3
E	37.9	1.20	26.8	0.92	35	0	420	10	4.5
F	37.4	0.52	24.2	0.42	35.1	0.2	437	13	5
G	33.7	0.70	24.8	1.68	32.8	0.5	420	10	4.5
H	29.9	0.70	29.0	1.54	32.5	0.58	457	13	5
I	26.1	0.70	22.8	1.15	22.3	0.50	427	23	5
J	32.3	0.70	25.6	2.56	35	0	450	15	6

a: The mean was calculated from 5 replicates for each sample, and from 7 samples (different times extending for weeks from one to the other) for each bakery.

DISCUSSION

If the percentage of dough moisture is taken, it is noticed that it fluctuates and varies from one bakery to another, and this indicates that the workers complete the kneading process by adding the amount of water in a non-uniform manner and in an uncontrolled manner. In bakery A, there is a large difference in the results between the replicates taken, which is reflected in an increase in the standard deviation (3.5). This transgression in defining the ingredients of the dough according to experience and research that consolidated professionalism and craftsmanship, was reflected in a discrepancy in the moisture values of the resulting bread, this discrepancy was evident in the high standard deviation (4.24) of the percentage of bread moisture as well. It also was found in the bakery itself a scattering of other values such as the diameter of the loaf, which is easy to adjust.

Another bakery, J, was able to adjust the diameter of the loaf completely without variation, but the moisture content in the bread was not controlled, and the dispersion in it was large, giving a standard deviation of (2.56), which means that the process of baking bread is not controlled in a way that depends on constants related to the temperature or speed of movement of the mat in the baking chamber. On the other hand, in bakeries E and F, it was found that dispersal in values is within acceptable limits, and this in turn reflects the commitment of their workers to professional and thoughtful work arrangements.

This variation in the specifications of the production of a food commodity of great consumer importance is an indication of the lack of compliance with the Syrian Standard Specification 3761-2014 related to baking, as well as sufficient evidence of the lack of professionalism or craftsmanship required by the workers in the bakery.

Knowing that the supply flour is distributed to bakeries by government institutions as a unified source for all those that produce the popular bread, and some of them show the results of their work less dispersed and deviated, which reflects the performance by comparison of the worker in arranging his work within the bakery.

Some of the technological results included in the table (1) can be processed based on mathematical statistics in order to model them in mathematical equations that show the mutual influence between parameters. If the percentage of bread moisture is taken, it will be affected by the moisture of the dough, as well as the baking temperature of the bread and the baking time.

Table (2-a):Results of the representation of mathematical equations for the relationship between the percentage of dough moisture as an independent variable and the percentage of bread humidity as a dependent variable

Model Summary and Parameter Estimates								
Dependent Variable: Percentage of bread moisture								
Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	b1	b2	b3
Linear	.979	421.527	1	9	.000	.696		
Logarithmic	.994	1.602E3	1	9	.000	7.191		
Inverse	.962	229.588	1	9	.000	887.741		
Quadratic	.995	761.946	2	8	.000	1.401	-.019-	
Cubic	.995	761.946	2	8	.000	1.401	-.019-	.000
Power	.998	4.887E3	1	9	.000	.905		
S	.971	303.803	1	9	.000	112.052		
Growth	.980	447.235	1	9	.000	.088		
Exponential	.980	447.235	1	9	.000	.088		
Logistic	.980	447.235	1	9	.000	.916		
The independent variable is Percentage of dough moisture.								

Here, bread moisture can be referred to in the mathematical sense as a dependent variable for another independent variable, which is the percentage of dough moisture, baking time, baking temperature, or all three together. Within this framework and depending on the SPSS program, the best mathematical equation has been searched for a reflection of the relation between the independent variable and dependent variable. For example, if the percentage of dough moisture as an independent variable (X) was taken and the percentage of bread moisture as a dependent variable (Y) will find the best equation of 10 mathematical equations shown in table (2-a), is the power equation that takes the form: $Y = X^b$, and replacing the value of the coefficient within the mathematical equation the formula is obtained $Y = X^{0.905}$, where the adjusted correlation coefficient specifically: $R^2 = 0.998$ is very high and reflects representation excellence of relationship between the correlated variables, as it is clear through the table (2- b).

Table (2-b) shows a summary of the results of the power equation model representation of the relationship between the percentage of dough moisture as an independent variable and the percentage of bread moisture as a dependent variable

Model Summary[a]			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.999	.998	.998	.147
The independent variable is Percentage of dough moisture.			
a. The equation was estimated without the constant term.			

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
ln(Percentage of dough moisture)	.905	.013	.999	69.910	.000
The dependent variable is ln(Percentage of bread moisture).					

A second relationship connects the baking temperature as an independent variable and the percentage of bread moisture as a dependent variable that was best represented among the ten proposed equations through the power equation, as shown by the results of Table (3-a).

Table (3-a): Results of the test results for the representation of mathematical equations for the relationship between baking temperature as an independent variable and the percentage of bread moisture as a dependent variable

Model Summary and Parameter Estimates								
Dependent Variable: Percentage of bread moisture								
Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	b1	b2	b3
Linear	.994	1.514E3	1	9	.000	.059		
Logarithmic	.995	1.697E3	1	9	.000	4.239		
Inverse	.992	1.179E3	1	9	.000	1.126E4		
Quadratic	.995	759.825	2	8	.000	.100	-9.302E-5	
Cubic	.995	760.794	2	8	.000	.079	.000	-1.060E-7
Power	.999	1.750E4	1	9	.000	.534		
S	.998	4.263E3	1	9	.000	1.419E3		
Growth	.998	5.416E3	1	9	.000	.007		
Exponential	.998	5.416E3	1	9	.000	.007		

Table (3-a): Results of the test results for the representation of mathematical equations for the relationship between baking temperature as an independent variable and the percentage of bread moisture as a dependent variable

Model Summary and Parameter Estimates								
Dependent Variable: Percentage of bread moisture								
Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	b1	b2	b3
Linear	.994	1.514E3	1	9	.000	.059		
Logarithmic	.995	1.697E3	1	9	.000	4.239		
Inverse	.992	1.179E3	1	9	.000	1.126E4		
Quadratic	.995	759.825	2	8	.000	.100	-9.302E-5	
Cubic	.995	760.794	2	8	.000	.079	.000	-1.060E-7
Power	.999	1.750E4	1	9	.000	.534		
S	.998	4.263E3	1	9	.000	1.419E3		
Growth	.998	5.416E3	1	9	.000	.007		
Exponential	.998	5.416E3	1	9	.000	.007		
Logistic	.998	5.416E3	1	9	.000	.993		
The independent variable is Baking temperature in centigrade.								

By substituting the value of the coefficient B, the formula is obtained: $y = X^{0.534}$, and the adjusted correlation coefficient is very high, $R^2 = 0.999$, which reflects the representation accuracy of the mathematical equation of the relationship between the two variables, and Table (3-b) illustrates this.

Continuing to show the relationship between bread moisture and one of the parameters, where there is a third relationship linking baking time as an independent variable and the percentage of bread moisture as a dependent variable.

Table (3-b) shows a summary of the results of the power equation model representation of the relationship between baking temperature as an independent variable and the percentage of bread moisture as a dependent variable

Model Summary[a]			
R	R Square	Adjusted R Square	Std. Error of the Estimate
1.000	.999	.999	.078
The independent variable is Baking temperature in centigrade.			
a. The equation was estimated without the constant term.			

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
ln(Baking temperature in centigrade)	.534	.004	1.000	132.276	.000
The dependent variable is ln(Percentage of bread moisture).					

The best mathematical equation for representation according to Table (4-a), the cubic equation, came from the form: $Y = b_1X + b_2X^2 + b_3X^3$.

Table (4-a): Results of the mathematical equations representation test of the relationship between baking time as an independent variable and the percentage of bread moisture as a dependent variable

Model Summary and Parameter Estimates								
Dependent Variable: Percentage of bread moisture								
Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	b1	b2	b3
Linear	.893	75.347	1	9	.000	1.613		
Logarithmic	.979	424.629	1	9	.000	9.706		
Inverse	.915	96.930	1	9	.000	309.623		
Quadratic	.995	867.690	2	8	.000	3.621	-.115-	
Cubic	.996	619.241	3	7	.000	4.389	-.217-	.003
Power	.985	584.298	1	9	.000	1.223		
S	.920	102.888	1	9	.000	38.997		
Growth	.902	82.464	1	9	.000	.204		
Exponential	.902	82.464	1	9	.000	.204		
Logistic	.902	82.464	1	9	.000	.816		

Table (4-a): Results of the mathematical equations representation test of the relationship between baking time as an independent variable and the percentage of bread moisture as a dependent variable

Model Summary and Parameter Estimates								
Dependent Variable: Percentage of bread moisture								
Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	b1	b2	b3
Linear	.893	75.347	1	9	.000	1.613		
Logarithmic	.979	424.629	1	9	.000	9.706		
Inverse	.915	96.930	1	9	.000	309.623		
Quadratic	.995	867.690	2	8	.000	3.621	-.115-	
Cubic	.996	619.241	3	7	.000	4.389	-.217-	.003
Power	.985	584.298	1	9	.000	1.223		
S	.920	102.888	1	9	.000	38.997		
Growth	.902	82.464	1	9	.000	.204		
Exponential	.902	82.464	1	9	.000	.204		
The independent variable is Baking-time in second.								

Substituting in the values of the coefficients, the equation is obtained: $Y = 4.389\,X - 0.217\,X^2 + 0.003\,X^3$. The adjusted correlation coefficient is also very high, $R^2 = 0.995$, which reflects the accuracy of the mathematical equation representation of the relationship between the two variables, and Table (4-b) illustrates this.

Table (4-b) shows a summary of the results of the power equation model representation of the relationship between baking time as an independent variable and the percentage of bread moisture as a dependent variable

Model Summary[a]			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.998	.996	.995	1.893
The independent variable is Baking-time in second.			
a. The equation was estimated without the constant term.			

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Baking-time in second	4.389	.634	2.572	6.923	.000
Baking-time in second ** 2	-.217-	.082	-2.293-	-2.650-	.033
Baking-time in second ** 3	.003	.002	.651	1.248	.252

The three parameters mentioned above (dough moisture, baking temperature, baking time) showed a remarkable effect on the bread moisture resulting from the baking process, and by adjusting them, the resulting bread moisture could be controlled, meaning the technological ripening process, and control of sensorial as well as rheological specifications of the resulting flatbread.

Table (5-a): Results of the mathematical equations representation test for the relationship between baking time as an independent variable and the length of the metal mat as a dependent variable

Model Summary and Parameter Estimates								
Dependent Variable: Length of the metal- mat in meters								
Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	b1	b2	b3
Linear	.832	44.700	1	9	.000	.276		
Logarithmic	.934	127.237	1	9	.000	1.682		
Inverse	.915	97.476	1	9	.000	54.968		
Quadratic	.961	98.326	2	8	.000	.676	-.023-	
Cubic	.971	78.463	3	7	.000	1.153	-.086-	.002
Power	.953	180.871	1	9	.000	.555		
S	.929	116.888	1	9	.000	18.071		
Growth	.853	52.190	1	9	.000	.091		
Exponential	.853	52.190	1	9	.000	.091		
Logistic	.853	52.190	1	9	.000	.913		
The independent variable is Baking-time in second.								

On the other hand, the baking temperature and baking time play a major role in choosing the length of the metal-mat belt, which enters the flatted dough into the baking chamber and makes the flatbread ripen properly. The relationship between the baking time as an independent variable and the length of the metal-mat belt as a dependent variable can be described by choosing the optimal mathematical equation among the ten equations in Table (5-a), to show that the cubic equation is the best represented, and by substitution with the values of the coefficients, the formula is obtained: $Y = 1.153\,X - 0.086\,X^2 + 0.002\,X^3$. The adjusted correlation coefficient $R^2 = 0.959$, is very high which reflects the strength of the correlation between the two variables, as is clear from Table (5-b).

Table (5-b) shows a summary of the results of the power equation model representation of the relationship between baking time as an independent variable and the length of the metal mat as a dependent variable

Model Summary[a]			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.985	.971	.959	.932
The independent variable is Baking-time in second.			
a. The equation was estimated without the constant term.			

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Baking-time in second	1.153	.312	3.807	3.694	.008
Baking-time in second ** 2	-.086-	.040	-5.124-	-2.135-	.070
Baking-time in second ** 3	.002	.001	2.277	1.573	.160

Table (6-a): Results of the mathematical equations representation test of the relationship between baking or roasting temperature as an independent variable and the length of the metal mat chain as a dependent variable

Model Summary and Parameter Estimates								
Dependent Variable: Length of the metal- mat in meters								
Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	b1	b2	b3
Linear	.967	261.815	1	9	.000	.010		
Logarithmic	.963	233.987	1	9	.000	.740		
Inverse	.955	189.385	1	9	.000	1.961E3		
Quadratic	.969	124.786	2	8	.000	-.003-	2.972E-5	
Cubic	.969	124.786	2	8	.000	-.003-	2.972E-5	.000
Power	.980	440.255	1	9	.000	.244		
S	.974	330.731	1	9	.000	646.375		
Growth	.982	502.056	1	9	.000	.003		
Exponential	.982	502.056	1	9	.000	.003		
Logistic	.982	502.056	1	9	.000	.997		

Table (6-a): Results of the mathematical equations representation test of the relationship between baking or roasting temperature as an independent variable and the length of the metal mat chain as a dependent variable

Model Summary and Parameter Estimates								
Dependent Variable: Length of the metal- mat in meters								
Equation	Model Summary					Parameter Estimates		
	R Square	F	df1	df2	Sig.	b1	b2	b3
Linear	.967	261.815	1	9	.000	.010		
Logarithmic	.963	233.987	1	9	.000	.740		
Inverse	.955	189.385	1	9	.000	1.961E3		
Quadratic	.969	124.786	2	8	.000	-.003-	2.972E-5	
Cubic	.969	124.786	2	8	.000	-.003-	2.972E-5	.000
Power	.980	440.255	1	9	.000	.244		
S	.974	330.731	1	9	.000	646.375		
Growth	.982	502.056	1	9	.000	.003		
Exponential	.982	502.056	1	9	.000	.003		
The independent variable is Baking temperature in centigrade.								

Another correlation between two parameters that contribute to controlling the technological conditions is the baking temperature and the length of the metal-mat belt that enters the baking room to give the technological condition that guarantees the completion of all physical, chemical and physicochemical developments within the baking room, and consequently the flatbread comes out within the desired specifications.

The relationship between the baking temperature as an independent variable and the length of the metal-mat belt that enters the roasting chamber as a dependent variable was tested through the results of the ten equations in Table (6-a).

The exponential relationship came with the best representation, it can be described with the substitution of the coefficient value through the mathematical equation: $Y = 0.003^X$, and the adjusted correlation coefficient is very high to reflect the strength of the correlation between the two variables referred to, and it reached to: $R^2 = 0.980$, as shown in Table (6-b).

Through the aforementioned statistical treatment that related two parameters only, it gave a narrow field of view for the interaction between parameters, and the treatment angle can be expanded to link more than one independent variable to a dependent variable. To begin with, the dough moisture (X1), baking temperature (X2) and baking time (X3) can be considered as independent variables, offset by a dependent variable, the percentage of bread moisture (Y). Using the concept of multiple correlation, it was found that the best representation of the relationship is the from:

Table (6-b) shows a summary of the results of an exponential equation model representation of the relationship between baking temperature as an independent variable and the length of the metal mat chain as a dependent variable

Model Summary[a]			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.991	.982	.980	.210
The independent variable is Baking temperature in centigrade.			
a. The equation was estimated without the constant term.			

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Baking temperature in centigrade	.003	.000	.991	22.407	.000
The dependent variable is ln(Length of the metal- mat in meters).					

$Y = 0.113X1 + 0.048\,X2 + 0.052\,X3$, and the adjusted correlation coefficient is very high, as it reached: $R^2 = 0.959$, which reflects the quality of the multiple correlation between the three independent variables and the dependent variable. This is evident in Table (7).

Table (7): Multiple correlation results for the relationship between dough moisture, baking temperature and baking time as an independent variable and percentage of bread moisture as a dependent variable

Model Summary				
Model	R	R Square[b]	Adjusted R Square	Std. Error of the Estimate
1	.997[a]	.995	.992	2.251
a. Predictors: Baking-time in second, Percentage of dough moisture, Baking temperature in centigrade				
b. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.				

Coefficients[a,b]

Model		Unstandardized		Standardized	t	Sig.
		B	Std. Error	Beta		
1	Percentage of dough moisture	.113	.133	.161	.853	.422
	Baking temperature in	.048	.013	.809	3.783	.007
	Baking-time in second	.052	.146	.030	.354	.734
a. Dependent Variable: Percentage of bread moisture						
b. Linear Regression through the Origin						

Table (8): shows the results of the multiple correlation of the relationship between the length of the metal chain and baking time as an independent variable and the percentage of baking moisture as a dependent variable

Model Summary				
Model	R	R Square[b]	Adjusted R Square	Std. Error of the Estimate
1	.983[a]	.967	.958	5.277
a. Predictors: Length of the metal- mat in meters, Baking-time in second				
b. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.				

Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Baking-time in second	.583	.269	.342	2.166	.062
	Length of the metal- mat in meters	3.728	.888	.662	4.196	.003
a. Dependent Variable: Percentage of bread moisture						
b. Linear Regression through the Origin						

Another multiple correlation is between the length of the metal mat chain (X1) and baking time (X2) as two independent variables with the percentage of bread moisture as the dependent variable, and it was found that the best representation of the relationship is from the figure: $Y = 3.728X1 + 0.583\,X2$, and the adjusted correlation coefficient is very high: $R^2 = 0.958$, which reflects the strength of the correlation and the accuracy of the representation process, and this is evident in Table (8).

CONCLUSION

The production of two-layer popular flatbread in Syria was subject to developmental factors that introduced bread technology to give a nutritional commodity distinguished in its sensory and rheological characteristics from the rest of similar bread produced in the neighboring countries of the region. Studying the production of two-layer popular flatbread revealed the following conclusion:

1) Parameters such dough moisture, baking temperature and baking time influenced final moisture content of the tow-layer flatbread loaf.

2) These parameters are still not realized by most workers in the production of two-layer popular flat bread.

3) Relationships between named parameters can be described with the help of mathematical statistics using mathematical equations (as

an independent variable and another as a dependent variable), which take the cubic, exponential or power form, meaning that the dependent variable can be predicted by knowing the value of the independent variable.

4) Best mathematical equations characterize the relationship between dough moisture and bread moisture takes the form: $Y = X^b$. Also this equation characterize the relationship between baking temperature and percentage of bread moisture too.

Best mathematical equations represent the relationship between baking time and the percentage of bread moisture takes the form: $Y = b_1X + b_2X^2 + b_3X^3$. Rrelationship between baking temperature and length of the metal-mat belt takes the form: $Y = b^X$.

Using the concept of multiple correlations between dough moisture (X1), baking temperature (X2), and baking time (X3) can be considered as independent variables correlated to the percentage of bread moisture (Y) as dependent variables in the form: $Y = b1X1 + b2\,X2 + b3\,X3$.

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