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Gamma Ray Effect on Wheat Bakery Properties in Roshan Cultivar by Artificial Neural Network

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ABSTRACT

Wheat is one of important cereals for human nutrition that its importance is mostly related to physical and chemical traits of gluten in wheat seed. The impact of mutation on traits can be determined by investigation of rheological behavior to study the physicochemical properties of bread dough in studied genotypes. Genetic variation was created by gamma ray from the cobalt-60 source. These genotypes were selected by specific primers related to LMW-glutenin subunits and change in Dx2+Dy12 alleles to Dx5+Dy10 ones. Chemical and Farinograph experiments were tested on seeds. In this study, sigmoid transfer function was used for assessment of factors in three layers by the model of feed-forward neural network with training method of levenberg-marquardt algorithm. Three chemical traits of Zeleny number, the hardness, wet gluten, and protein content in Roshan3 line increased significantly compared to the control. Studying Farinograph traits In Roshan3 line indicated significant increase in water absorption percentage, dough stability and valorimeter value but dough softening after 10 and 20 minutes reduced significantly compared to the control. In the artificial neural network carried out based on levenberg-marquardt algorithm for chemical and Farinograph traits protein content, bread volume, Farinograph quality number and E10 had the greatest impact on neural network model. These results indicate that mutation is able to change the qualitative characteristics.

Key words: Wheat, Mutant, Farinograph test, Chemical experiments, Artificial neural network

INTRODUCTION

In a society, which its population is increasing, food product subject has been emphasized in an extraordinary way. Universal agriculture's crop organization and international agency of nuclear energy, in 1964 related to nuclear tactics and food products, signed an agreement in order to use nuclear energy in a proper way to improve and solve agricultural problems; and isotopes and radioisotope rays ran to help Agricultural studies and made a huge revolution in agriculture industry through this approach (1). Wheat is one of the most important cereal for human's nourishment that can provide about 70 to 60 percent of our nurture energy. The importance of wheat is mostly related to physical and chemical gluten benefits in the wheat seeds. Baking quality of wheat is under the control of genome and environmental implant conditions. Therefore, this feature can be ameliorated by genetically correction. The most significant limitation for plant correction is genetically variety which is removable by using mutagens (1).

Experimenting on four wheat genotypes, Corpuz [2], observed about 0.7 to 2 percent protein in the wheat seeds through 3 year increasing in the 8, 9 and 10 Mutations generation after creating chemical Mutations. Mangova [3], by studying on 15 hybrid mutant lines and 2 Mutational lines in the result of physical and chemical. Mutations in 3 attribute features quality, dough of softening and energy for dough's transformation in the (MX77/12) toward the amount, observed a prominent difference. Protein percent, dough of softening and required energy for dough's transportation was significantly different. With Gama, number 4 irradiation wheat Sonora 64, they had observed 1 to 2 percent protein improvement that syrupy number of Sonora which is one of the mutant's line, is being planted in India nowadays [4]. With seeds irradiation F1 wheat 200 dose Kozub [5], had observed that changes are abounded in glutenin gene in mutants were 7.4 percent which in comparison with control had increased 0.5 percent in a significant way. Results showed that irradiation made gene go blackout in glutenin gene this function caused increasing glutamine much more than gliadin and in result increased the quality of baking wheat.

Artificial neural networks have that ability to train some of the experimental data without needing to know the real physical and chemical governing system laws. Thus, artificial neural networks where available system was nonlinear and showed a complex action is very important [6]. Safa [7], in predicting the wheat function while using artificial neural networks achieved checking 140 different factors, 6 under cultivation area doctors, raining amount, using agricultural tools, agricultural organs with the greatest impact in the New Zealand. Artificial neural networks is being used for predicting the function of agriculture crops such as wheat [4,8,9] and corn.

Zamani [10], had checked genotype mutant baking quality and their parent with the use of specific primers beneath glutenin units with high molecular weight through the polymerase chain reaction (PCR). Studied Genotypes in this research according to the change of these 2+12 reasons (as the allele with negative impact on baking quality) 5+10 (as the allele with positive impact on baking quality) had been chosen as the results Zamani [10], of reviews. According to this due to irradiation with gamma rays with an obvious number of 2+12 in mutant contains RO-5, RO-3, RO-1 due to (radiation with obvious number) 5+10 were obtained as allele with positive impact on baking quality were tested.

Studying about rheological uses, dough is one of the fastest and the most reliable approaches for measuring quality indicators and food grain texture is considered as wheat flour as well. So, part of this study is about rheology actions for studying physical and chemical features of bread dough such as water absorption, the stability of dough versus blending, the degree of dough looseness, the most resistance of dough, the ability of dough elasticity, and dough energy in the used genotypes and showing the impact of mutation on baking quality traits.

MATERIAL AND METHODS

Plant Materials

In this research, three mutant lines which were the outcome of radiating the common commercial number of Roshan wheat were analyzed. These numbers were radiated in order to achieve the lines with high quality characteristics with the radiation dose of 200 gray (cobalt resource 60) and the moisture amount of 14-11% after the cooperation of Iran atomic institute and the international atomic energy agency and the population of mutants were made. The above mentioned mutant lines were utilized for 12 years after purification.

Wheat flour quality tests

Out of the harvested seeds from the farm, in two repetition of the chemical traits, the percentage of the wheat seed moisture via the USA chemical association of cereal AACC 56-60, the amount of the wet gluten through 38-10 AACC, the seed hardness by utilizing the undramatic device 8100, the protein percentage by 46-12 AACC and the volume of Zeleny deposition through AACC 56-60 and the flour rheological traits via the infrared spectrum analyzer were measured. The related traits to the Farinograph test, by the use of Brabender Farinograph model 18507 (5) including the amount of water absorption, dough development time, dough stability and endurance, dough softening time after 10 and 20 minutes, dough Valorimeter value and the Farinograph quality number were done in the chemistry laboratory of cereal in the seed and plant improvement institute of Karaj. The achieved results were analyzed in an absolute accidental format using statistical software MSTAT-C.

Artificial neural network

Each neural network built-up of some layers for each neural first layer related to independent variables and the last layers is related to dependent variables [11]. In this study 6 chemical factor including protein, Zeleny Sediment, Wet gluten, bread amount, bread hardness, and the moisture absorption in both models were used as independent variables. Also, seven Farinographic factors including dough development time, the stability of the dough, time that the dough gets to Brabender curve 500 line, water absorption rate, dough's softening time after 10 or 20 minutes and Farinograph quality number were studied under total of 13 model to achieve the best predicted quality in baking wheat. It should be noted that dough valorimeter value is considered as an output factor. In this research with the use of Sigmoid transfer function in 3 layers which were in use through the resources model- Feed-forward artificial neural network by using the Levenberg-marquardt algorithm method to check the factors were used. In order to use the sigmoid function, all the experimental data (X_i) must be normalized through the relation number 1 within the range of 0.1 to 0.9.

$$\text{Function number 1} \quad x_i = 0.1 + \frac{0.8(X_i - \min(X_i))}{\max(X_i) - \min(X_i)}$$

After training system in order to determine optimum hidden neurons topology layer had been used. For evaluating the profitability of neural, multiply values, mean square errors, mean errors were used as Error functions. These functions were calculated by using relations number 2 and 3 [11].

$$\text{Function number 2} \quad MSE = \frac{\sum_{i=1}^n (y_{nn} - y_{exp})^2}{n}$$

$$\text{Function number 3} \quad MAE = \left(\frac{1}{n}\right) \sum_{i=1}^n |y_{nn} - y_{exp}|$$

In the above function, n is the number of data, i is the data index, y_{nn} is rate of predicted answers by neural network and y_{exp} is laboratory results obtained for the process answer. The aim of neural network training is to achieve the least error function. In this research, multi-layer Perceptron neural network is used with a teaching algorithm. To teach the neural network, from the experimented data, 70% for training 15% for network test and 15% for evaluation and network correction were used. By analyzing Parto, they had calculated the effect amount of variables and their opposite reaction on the answers. And also they calculated the percentage of each parameter impact using developed model factors according to the relation below (25).

$$P_i = \left(\frac{\beta_i^2}{\sum \beta_i^2} \right) \times 100$$

In the improved model (pi) is the percentage of every parameter and (Bi) s are related factors in the developed model.

RESULTS

Measuring chemical features of flour

The best way to show the quality of wheat, its function in industry, baking quality, final crops quality is evaluating its technological features. Due to this purpose determining amount and quality of protein, sediment amount, and bread amount, hardness of bread, moist gluten, gluten index and being aware of its rheological specifications is important [2]. It can be concluded that Roshan flour is a strong flour, in biotype related to Roshan with due attention to bread amount. There is a stronger connection between strong flour with strong gluten, that's why keeping gas in this flour is less possible. Because bread amount in mutant sample had decreased unto the controlled sample (Table 1). Hardness of bread, gluten's moisture and protein percentage in Roshan 3 line increases noticeably. We can relate the increase of protein and gluten's moisture to break graft among protein parts, especially gluten's components are other wheat flour's mixtures such as starch and fiber (Table 1). To determine protein's quality both gluten's quality and amount are effective. In this research gluten's quality was defined with Zeleny experiment. Zeleny number is subject which has no other meaningful differences for wheat's chemical features with lucid number but Roshan lines. Shahinnia [12], reached a conclusion by studying 145 complex wheat seeds from 90 amendatory lines and 55 native numbers and arable and measuring traits of seed hardness and the amount of Zeleny Sediment with coefficients of variation respectively 11.83 and 13.51 which had the most variety of all. Analyzing factor results based on quality traits was clear for two factors of seed's protein percentage and bread amount with 98.23% from the variation of all the data and a meaningful variance was observed in this experiment as well.

Table-1: Mean Comparison of chemical properties

Wet gluten	Seed moisture	Seed hardness	Bread volume	Zeleny	Protein content	Genotypes
22b	11.05a	45b	625.5a	30b	10.95b	Roshan
20.75b	11.28a	45.75b	605.5a	32.5b	10.85b	Mutant of Roshan 1
32.5a	11a	54a	542a	38.5a	12.55a	Mutant of Roshan 3
20.65b	11.5a	45b	589.5a	31b	10.9b	Mutant of Roshan 5

Similar letters represent that there is no significant difference in each trait.

Farinograph

In this experiment, they checked flour's water absorption factors, Farinograph quality number, dough stability, dough development time, dough softening time after 10 or 20 minutes and valorimeter valuation another time. Researching rheological traits show that for absorbing wheat's water there is a great difference Roshan3 mutant line and the controlled one, mutant wheat's water absorption rate is much more than the controlled one. This shows that the capacity of holding water in Roshan3 is more than control. Dough stability shows some information about flour's ability in mixture. It had been cleared that the rate of dough stability and the Farinograph width of the curve has increased which shows lack of stability of this sample in mixture.

Farinograph quality number is a conventional standard that has presented by Brander Company [13] and comparing the quality number in Roshan3 mutant wheat it showed a significant difference toward control so that this number in Roshan3 mutant sample was reported more than control sample. The reason of this is because of increasing stability and increasing the rate of softening in dough in Roshan3 mutant's line (Table 2). Valorimeter values that represent dough tensional specifications. It depends on some factors like dough softening. By researching, it was found that Roshan3 mutant had better tensional specifications than the controlled one.

Softening level of dough showed a very significant difference towards its control after 10 or 20 minutes in wheat flour Roshan3 mutant. Studying about the resulting data in the control sample represents the weakening and reducing tolerance of dough toward mixing.

In investigating the genetic variety of 85 numbers of the bread wheat cultivars, considering the quality of baking the Farinograph and the chemical traits of cereal using the methods of multi-variables and decomposing into the factors, out of 12 traits which were under investigation, there were 3 factors with the probable variance of 97 were obtained that the first factor with 79 percent variance Farinograph characteristics, the second factor with 17 percent variance for protein amount, bread and Zeleny sediment and the third factor with 1.75 percent variance contained index features of gluten and sediment amount with SDS [3]. Gupta [14], reported that more protein in the wheat, leads to increase in the elasticity of dough which had correspondence with the results of this research. Fowler and Delaroche [15], reported that we shall use the amount of protein as a variable in predicting the baking quality.

Table-2: Farinograph test results of wheat flour of genotypes

Valorimeter value	E20	E10	Dough stability	Farinograph quality number	Dough development time	Water absorption	Genotypes
39b	130a	115a	2.75b	37.5ab	2ab	55.85bc	Roshan
36b	142.5a	113.5a	2.69b	33.25ab	1.375c	54.35c	Mutant of Roshan 1
48.5a	90b	60b	4.9a	59a	2.125a	58.9a	Mutant of Roshan 3
36.5b	140a	114a	2.75b	21.375b	1.625bc	57.9ab	Mutant of Roshan 5

Similar letters represent that there is no significant difference in each trait.

The model of the artificial neural network

In this study the first 6 factors are chemical features that respectively include protein percentage, Zeleny sediment, bread volume, seed hardness, the moisture and absorption's amount and the related gluten. The next seven factors, from seven to thirteen, include Farinograph parameters like the percentage of water absorption, dough development time, the time that dough reaches to 500 line of Brabender curve. Quality number of Farinograph, stability and durability of dough, time softening of dough after 10 or 20 minutes and 13 factors were studied over all so that the best model of baking wheat prediction become clear. It should be noted that the value of valorimeter dough is considered as a factor output.

The results of analysis Parto in the Figure 1 is pointed to output baking quality. Among studied factors with the use of chemical factors, containing the percentage of protein [16] and volume of bread [17] and Farinograph test containing Farinograph quality number [18], and dough softening time after 10 minutes [19] had a great impact on baking quality of wheat. Four parameters which were mentioned above with following impact percentage 8.5, 11, 10.7 and 10 percent are considered as the most effective parameter on baking quality. In this research the Neural network resources with teaching Levenberg-marquardt algorithm and topology 13:10:1 had been used for model making of defining effective parameters in quality of baking wheat.

Sigmoid transfer function is being used as hidden layers and artificial neural network outputs propagation transfer function in a great way. What is in hand is Coefficient of determination equals to 0.99985, the mean average error equals to 0.00003 and the average error equals to 0.0022 from the best educational system. We may calculate by using obtained weights and biases the relative importance of input and effective variables on the output.

The coefficient of determination for the test curve 0.964, affirmation curve 0.999, training curve 0.999 and 0.999 overall. Neural network training among 24 laboratory data had been achieved. 70% training 15% for test network, and 15% validation were used.

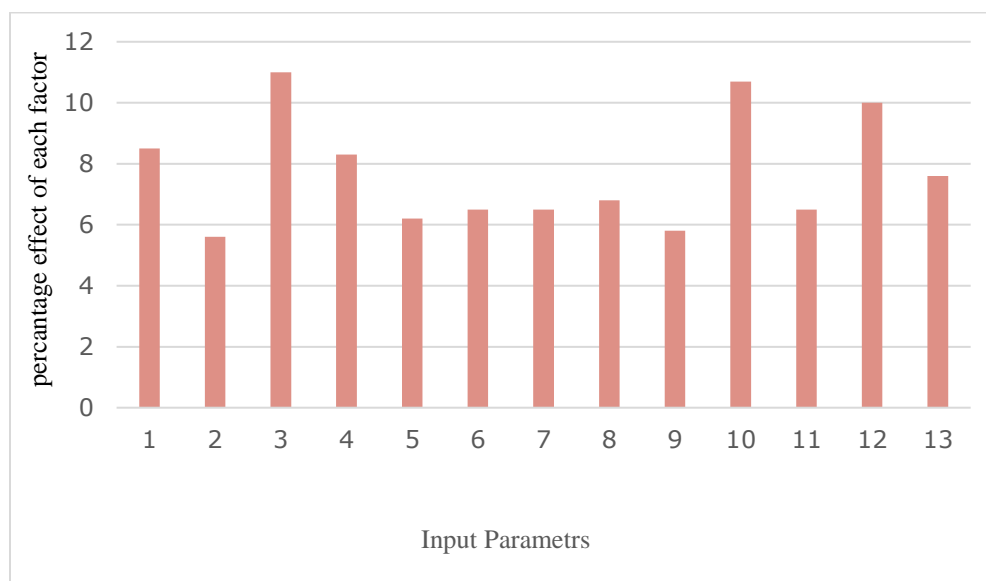


Figure-1: Parto analysis for determination of effect of each factor on response (MAE=0.00003 & MSE=0.0022)

The results show that Mutations are able to make changes in quality traits and some attributes that can be controlled by some locus. Also, they can create greater genotypes than parents (sources). Also, the results in hand are not harmonized with molecular tests. This is due to baking quality traits are controlled by some locus and reviewing gene changes is not a reason for meaningful

change in the baking quality. Also, the results of artificial neural network are as follow: great impact of bread, Farinograph quality number, the time that paste gets soft after 10 minutes and protein percent in the quality of baking wheat.

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