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Study of osmotic dehydration of banana using calcium lactate and genetic algorithm optimization of process

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Introduction: Banana is one of the most popular tropical fruits in all over the world with notable post-harvest losses. Due to its high moisture content preventing long preservation period. So, it needs a proper preservation method to prevent product lost especially in main produceing countries. Since banana is an un-freezable fruit, thermal processing such as drying or canning could be more appropriate for prolonging its shelf life. On the other hand, high energy consumption and being cost intensive are two most important disadvantages of thermal processing. In order to decrease the side effects of thermal process on quality parameters, pretreatment of samples could be applied to reduce time of main process.Osmotic dehydration is a non-thermal pretreatment which provides partial removal of water by immersing sample in an osmotic solution.But this process also takes a long immersion time to enough reduction of moisture. So this leads to undesirable effect on texture and colors.This study was performed to eliminate some side effects of osmotic dehydration on quality and finally introduce an optimized condition resulting best performance of process.A novel all-knowing method for optimization of process is genetic algorithm (GA) which is a search heuristic that mimics process of natural selection. It generates solutions for the optimization of problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover. In this research, genetic algorithm was applied to predict optimum condition of osmotic dehydration.

Material and methods: Osmotic dehydration was performed using aqueous solution of sucrose in concentration of 45% (w/w) for immersion time of 3 hr. The first challenge was improving mechanical properties of banana slices by adding calcium lactate to sucrose solution in concentrationsof 0, 2, 3 and 4%.For the next step in order to protect samples from enzymatic browning mixture of ascorbic acid (0.25 %) and citric acid (0, 0.5, 1, and 1.5%) were used.The pH of solution was measured for each level of adding citric acids. The efficiency of operation was estimated by computingwater loss and solid gain. Firmness of dehydrated samples wasmeasured using a texture analyzer (INSTRON, 1140, Singapore) and penetration test. Image acquisition technique was applied to measure L^*, a^* and b^* indices.The coefficient of efficiency was defined as the ratio of water loss to solid gain and calculated to estimate performance of treatment in new condition. Finally, optimized conditionsfor maintaining the lowest solid gain and color changes, the highest water loss and firmness waterlosswere predicted by genetic algorithms method. The accuracy of model was investigated using statistical parameters such as mean absolute error (AME), normalized mean square error (NMSE),mean square error (MSE).

Results and discussion: The results of experiments showed a significant increase of firmness by adding lactate calcium. This observation was due to complex formation between calcium and cell wall ingredients. Thesecomplexes have a decreasing effect on solid gain.Because complexes preventedmacromoleculesentering such as sucrose to the cells.On the other hand,calcium lactate and citric acid had interaction on mentioned parameters.Firmness showed less firmness when citric acid was added to the solution. Because citric acid as a chelating agents can blockdivalent cations and prevent from effective reaction with plant cells.Also citric acid can disconnect methoxyl groups from protopectinproducing softer texture.However, treated samples still showed firmer texture than control sample. It could be due to the additional effect of citric acid which makes carboxyl groups available for divalent calcium cations during conversion of protopectin to the pectin.For color parameters,only use of citric acid could not decrease the total change of color because yellow index increased due to the hydration of citric acids. But for the use of two factors, a significant decrease of total change of color was observed.For water loss, increase of solvents in each treatment led to raise of water loss due to the increase of osmotic pressure.In this circumstance determination of suitable concentration for each factorresulting best

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performance is complex, so it is necessary to apply a system canpredict optimized conditions. Genetic algorithms estimated optimum condition formaximum firmness and water loss, minimum solid gain and total change of color.In this condition the concentrations of lactate calcium and citric acid were %3.99 and %0.86, respectively. Also predicted values for water loss, solid gain, firmness and total change of color were earned %18.01, %5.07, 1.47 N and 11.37.MAE, NMSE and AME parameters (2.062, 0.021, and 1.099 respectively) were used for investigation of difference between estimated and experimental data which showed high efficiency of genetic algorithm for optimization of osmotic dehydration of banana.Investigating the efficiency ofcoefficient of treatments showed that application of both factors (calcium lactate and citric acid) significantly had more efficiency in comparison to the control samples regarding quality factors.

Keywords: Calcium lactate, enzymatic browning, genetic algorithm, optimization, osmotic dehydration.