Available *online* at: http://ajeeet.ft.unand.ac.id/

Andalas Journal of Electrical and Electronic Engineering Technology

ISSN 2777-0079

Research Article

The Use of Artificial Neural Networks (ANN) in the Chayote Chips Dough Mixer

Roza Susanti[1], Zas Ressy Aidha[1], Surfa Yondri[1], Sir Anderson[2], Tri Oktaviandra[2]

[1] *Electrical Engineering Department, Politeknik Negeri Padang, Indonesia*
[2] *Mechanical Engineering Department, Politeknik Negeri Padang, Indonesia*

ARTICLE INFORMATION

Received: November 7, 2022
Revised: November 25, 2022
Available online: December 30, 2022

KEYWORDS

Chayote Chips, TCS3200, RGB Color Sensor, Artificial Neural Network

CORRESPONDENCE

Phone: +62 823-8477-7192

E-mail: rozasusanti.pnp@gmail.com

A B S T R A C T

This study uses a backpropagation neural network to determine the evenness of the chayote chip dough. The Tcs3200 Color Sensor mounted on the stirrer alt is used as a sensor to determine the color of the chayote emping dough. A regression score of 1 indicates that the input and target data match in the test results of the artificial neural network, which has an objective error (MSE) value of 0.0096306 achieved in the 313th epoch. Changes in RGB color readings on the TCS sensor from min values <40 and max values>52 in mixing dough are influenced by distance and light intensity which will be converted in the form of frequency.

INTRODUCTION

The development of science and technology in modern times has experienced a very significant increase in an effort to ease the human workload. Chayote processing is one of the foods [1] businesses involved in the production of processed snacks in West Sumatra, specifically in Tanah Datar District and Salimpauang District. Chayote has become a popular home product [2], not only as a vegetable but also processed into snacks such as chayote chips [3]. In this processing process, the Salimpauang people still do it manually, using human labor, while the demand has started to increase [4]. So, with that, an automatic system tool was created for the dough mixing process to make it more practical and effective [5].

The use of color sensors is needed to detect the color of the dough in the chayote chip dough [6]. The color sensor will be connected to the Arduino UNO microcontroller as the main control of the chayote stirrer automatically [7]. The use of artificial neural networks (ANN) to determine the next process that will be carried out from the chayote mixer groove, which was originally traditional to see the color change of the dough, becomes automatic.

Chayote Chips

Sechium edule, a fruit vegetable with nutritional value that is rich in vitamins and minerals, is known as chayote [8]. Calcium and vitamin C levels are pretty good [9], and the potassium content is high enough to have the potential to be used as a meal to control blood pressure [4]. Chayote chips are dry-fried foods that are crunchy and include crackers, so they are more durable. In the processing of chayote chips, there are 3 stages: mixing the dough, steaming, and frying.

Figure 1. Chayote Chips

Chayote chips are made by mixing a variety of ingredients, such as wheat flour, cornstarch, baking powder, eggs, and salt, to create the dough [4]. The composition is then stirred, and the even

https://doi.org/10.25077/ajeeet.v2i2.27

distribution of the dough can be assessed by observing the chemical reaction of the composition that results in variations in the dough's color and aroma.

TCS3200 Sensors

The TCS3200 is a monolithic CMOS IC that combines a silicon photodiode arrangement with a current-to-frequency converter to create a color-to-frequency programmable converter [10]. This sensor outputs a square wave with a frequency that is directly related to the amount of light present, with a 50% duty cycle (irradiance) [11].

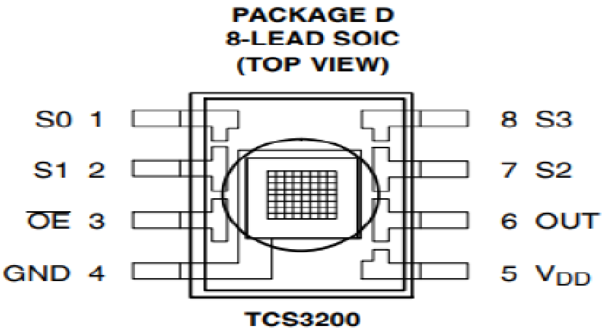

Figure 2. TCS3200 Sensors

This sensor module's digital inputs and outputs enable a direct connection to a microcontroller or other logic circuit [12]. We are able to determine the intensity of each color by using various filters [13]. By giving the control pins S2 and S3 the logical values LOW and HIGH, the filter is selected [14].

Arduino UNO R3

Arduino UNO is a microcontroller board primarily based totally at the ATmega328P [15]. It has 14 virtual input / output pins (of which 6 may be used as PWM outputs), 6 analog inputs, a sixteen MHz ceramic resonator, a USB connection, an energy jack, an ICSP header and a reset button. It includes the whole thing had to aid the microcontroller; really join it to a pc with a USB cable or energy it with an AC-to-DC adapter or battery to get started [16].

Artificial Neural Network

An ANN is primarily based totally on a group of linked gadgets or nodes referred to as synthetic neurons [17], which loosely version the neurons in an organic brain. Each connection, just like the synapses in an organic brain, can transmit a sign to different neurons [18]. A synthetic neuron gets indicators then methods them and may sign neurons linked to it.

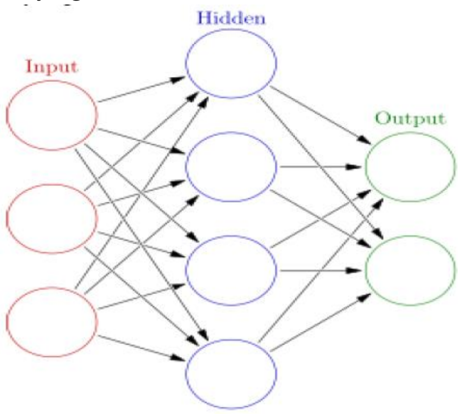

Figure 3. Artificial Neural Network Concept

The "sign" at a connection is an actual number, and the output of every neuron is computed through a few non-linear features of the sum of its inputs [19]. The connections are referred to as edges [20]. Neurons and edges normally have a weight that adjusts as mastering proceeds. The weight will increase or decreases the electricity of the sign at a connection. Neurons may also have a threshold such that a sign is despatcher most effective if the combination sign crosses that threshold [19].

The purpose of this study was to determine the level of color evenness of the chayote chips dough using a backpropagation Artificial Neural Networks (ANN) with RGB color sensor input values.

METHOD

To create the instructions that will be employed in the tool work system, software design is carried out. Making a program algorithm is the initial step in software design. An outline of a program's flow is provided for one version of the algorithm in the form of a flowchart. The goal of creating this flowchart was to make it simpler to comprehend how the tool functions. Figure 4 below shows a flowchart for software design.

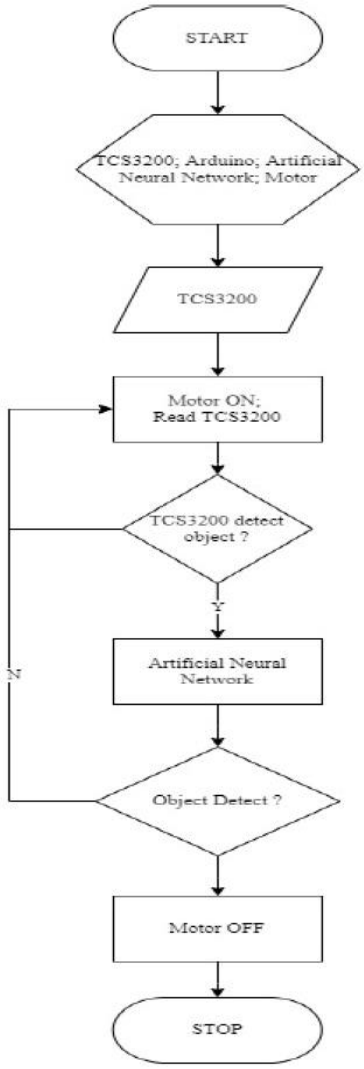

Figure 4. Flowchart Software Design

The training process and the testing process are the two procedures that make up an artificial neural network. As demonstrated in Figure 5, where the image employs one input node, one hidden layer node, and one output layer node, designing a backpropagation artificial neural network structure is the first stage that needs to be completed in the software design process.

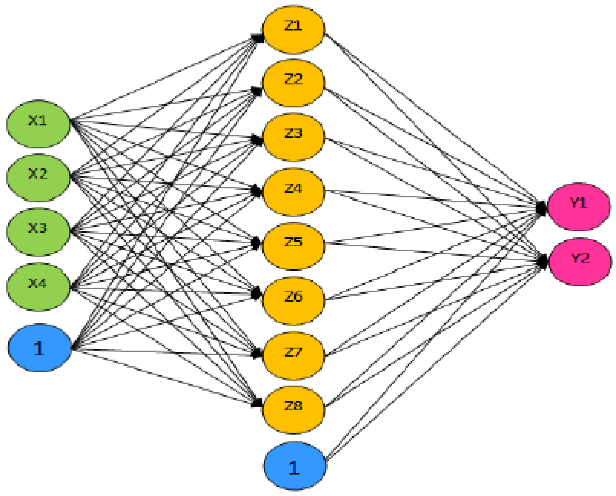

Figure 5. ANN Method Models

The identifying procedure is the following phase. This procedure is very similar to the training procedure. The distinction is that the weighted value for the training results is already included in the procedure [20]. Designing anything to be constructed in a mechanical form is known as mechanical design. Figure 6 displays the mechanical design outcomes for the finished project.

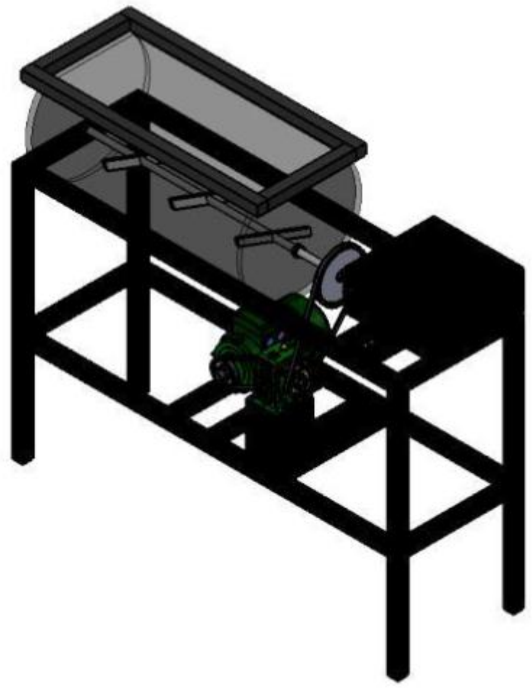

Figure 6 Mechanical Design Project

This dough mixer's mechanical construction resembles a mixer with proportions of 1 m long, 40 cm broad, and 70 cm high. A control box is there, and it measures 25 cm long, 20 cm wide, and 10 cm high.

RESULTS AND DISCUSSION

By observing color changes in the stirring of chayote chip dough, this sensor response is tested. The anticipated outcomes are sensor data readings gathered as test data for every hue until the average value of the data is consistent with the dough. The findings of measurements taken while the chayote chip dough was being stirred are listed below.

Table 1. The response of the chayote cracker dough to the sensor

Sample	Sensor Reading Value			Description
	R	G	B	
Dough Process	249	190	65	Initial stage of mixing ingredients
	247	192	68	Dough Collection Process
	235	188	70	Dough stirring process
	221	180	33	Dough stirring process
	223	176	28	Soft dough
	230	170	31	Soft textured dough
	226	140	25	The dough is sticky and soft
	223	150	20	Dough texture is smooth and even

From table 1, it can be inferred that the RGB value from the TCS 3200 sensor reads changes in the dough of 5 kg chayote, 5 kg tapioca flour, and 5/4 kg wheat flour at a value of R=223, B=150, and G=20. The average value of each RGB value is provided by the results based on tests 1 through 5. The average RGB value for the experiment with the chayote cracker dough is shown in Table 2.

Table 2. The average RGB value for the experiment

Test	TCS 3200 Sensors		
	R	G	B
1st	220	154	22
2nd	222	147	20
3rd	228	152	24
4th	215	152	23
5th	223	150	20
Average	**221.6**	**150.6**	**21.8**

The reading of the dough changes up to the specified texture must therefore reach the RGB value of the TCS 3200 sensors with an average of R 221, G 21, and B 150. Figure 7 is a graph of the average RGB value for the experiment.

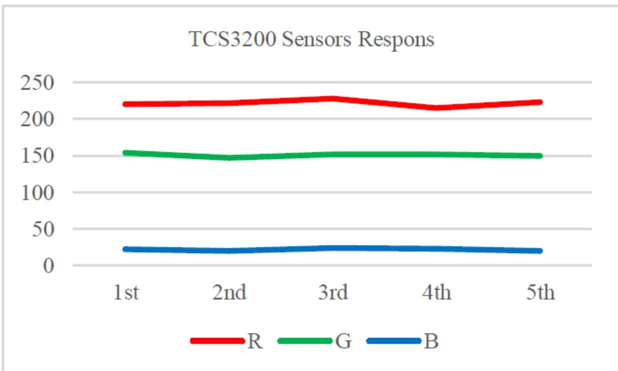

Figure 7. Graph of the Average RGB Value for the Experiment

 https://doi.org/10.25077/ajeeet.v2i2.27

The following stage is training based on the provided input and the desired aim. The training procedure is shown in Figure 8.

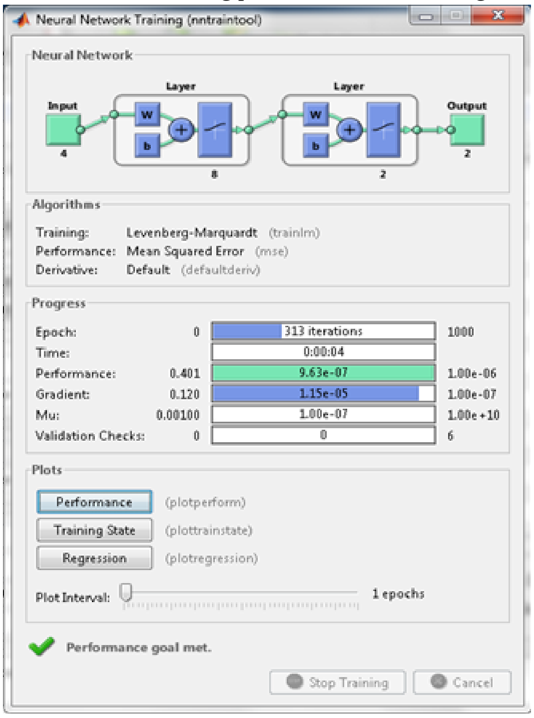

Figure 8. Training Procedure

From the graph above, it is clear that the error objective (MSE) value was attained at 0.0096306 in the 313rd epoch and that the regression value had a value of 1, indicating that the input data and the target were well-matched. The training results are displayed on the GUI in the form of the level of training accuracy, the total amount of data, the number of correct data, and the number of incorrect data after the training process is complete. The weight graph of the training results is depicted in figure 8 and can be viewed based on the data provided.

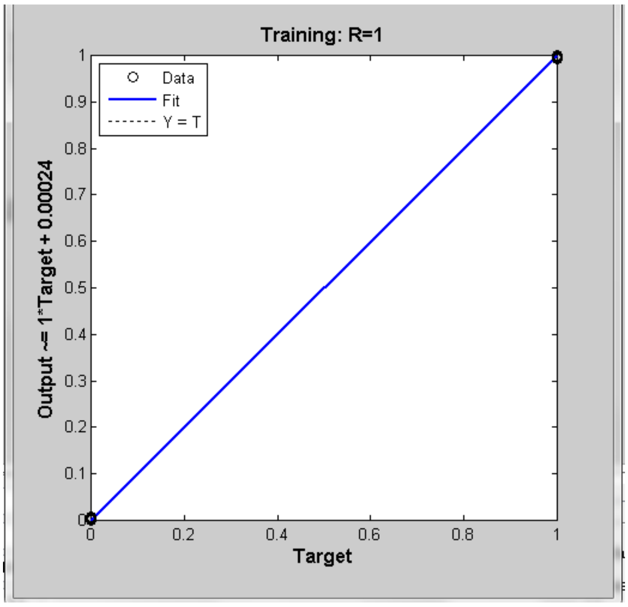

Figure 9. The Weight Graph of the Training Results

The following step involves doing training using the provided input, the weights collected from the prior training, and the intended aim. The prior training procedure is the same as this procedure. The next stage is to save network data and weight data so they may be processed during testing.

Table 3. Training TCS300 Results

TCS 3200 Sensors			Output
R	G	B	
223	150	20	Dough texture Final
220	150	22	Dough texture Final
223	150	20	Dough texture Final
221	151	18	Dough texture Final
223	150	20	Dough texture Final
225	155	21	Dough texture Final
223	150	20	Dough texture Final
224	153	25	Dough texture Final
223	150	20	Dough texture Final

Following the identification of the chayote chip dough, training is what led to Table 3. The network was able to classify all of the data as "dough texture final" from the incoming data. So, there is no failure in identification. To create the final chayote dough, a goal value is assigned to each piece of dough data.

CONCLUSIONS

This automatic dough mixer experiment led to the conclusion that distance and light intensity, which would fluctuate in the form of frequency, caused variations in RGB color readings from min values of 40 to max values of 52 when mixing dough. Color sensor identification is done in the Chayote puck dough mixer, and the average RGB value is obtained. The test results from the artificial neural network have an error goal value (MSE) of 0.0096306, which was attained in the 313rd epoch, and a regression value of 1, which denotes the degree of data fit between the input and target data. To create a smooth texture, the dough should be colored R=52, G=51, and B=42. The value that the TCS3200 sensor measures depends on where the sensor is placed on the stirrer. The reading of the dough changes up to the specified texture must therefore reach the RGB value of the TCS 3200 sensors with an average of R 221, G 21, and B 150.

ACKNOWLEDGMENT

Thank you to the Direktorat Jenderal Pendidikan Tinggi, Riset, and Teknologi Kementerian Pendidikan, Kebudayaan, Riset, and Teknologi, through Pusat Penelitian dan Pengabdian Politeknik Negeri Padang.

REFERENCES

[1] E. Díaz-de-Cerio, V. Verardo, A. Fernández-Gutiérrez, and A. M. Gómez-Caravaca, “New insight into phenolic composition of chayote (Sechium edule (Jacq.) Sw.),” *Food Chem.*, vol. 295, pp. 514–519, Oct. 2019, doi: 10.1016/j.foodchem.2019.05.146.

[2] A. Fu *et al.*, “Combined genomic, transcriptomic, and metabolomic analyses provide insights into chayote (Sechium edule) evolution and fruit development,” *Hortic. Res.*, vol. 8, no. 1, p. 35, Dec. 2021, doi: 10.1038/s41438-021-00487-1.

[3] N. I. Sulistiyani, A. Ainurrofiq, and V. Suryanti, “Antibacterial Activity of Chayote (Sechium edule Swartz) Squash Extracts and Their Phytochemical Constituents,” *J. Biodivers. Biotechnol.*, vol. 2, no. 1, p.

26, Aug. 2022, doi: 10.20961/jbb.v2i1.61330.

[4] R. W. Arief, Soraya, R. D. Tambunan, R. Asnawi, and N. Abdullah, "Diversify the processing of chayote (Sechium edule) into dodol to increase its added value," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 807, no. 3, p. 032048, Jul. 2021, doi: 10.1088/1755-1315/807/3/032048.

[5] J. Bal Krishna, S. Shreesti, A. Bibechana, and B. Mukunda, "Traditional Practices and Genetic Diversity on Chayote Landraces and Their Conservation," *Nat. Resour. Sustain. Dev.*, vol. 10, no. 2, pp. 272–288, 2020, doi: 10.31924/nrsd.v10i2.060.

[6] A. Jain, A. Saify, and V. Kate, "Prediction of Nutrients (N, P, K) in soil using Color Sensor (TCS3200)," *Int. J. Innov. Technol. Explor. Eng.*, vol. 9, no. 3, pp. 1768–1771, Jan. 2020, doi: 10.35940/ijitee.B7089.019320.

[7] Sarjana, E. Hesti, and Sholihin, "Coffee Groping Control System using tcs 3200 Sensor Based on xbee," *J. Phys. Conf. Ser.*, vol. 1167, p. 012017, Feb. 2019, doi: 10.1088/1742-6596/1167/1/012017.

[8] K. B. Swain, S. Mahato, M. Patro, and S. K. Pattnayak, "Cattle health monitoring system using Arduino and LabVIEW for early detection of diseases," in *2017 Third International Conference on Sensing, Signal Processing and Security (ICSSS)*, May 2017, pp. 79–82, doi: 10.1109/SSPS.2017.8071569.

[9] M. Valle Arizaga *et al.*, "Cryopreservation of in vitro shoot tips of chayote (Sechium spp.) by D cryo-plate method," *Acta Hortic.*, vol. 1234, pp. 293–300, Feb. 2019, doi: 10.17660/ActaHortic.2019.1234.38.

[10] A. Dhawan, P. Kaushal, and R. P. Mudhalwadkar, "Development of Low Cost and Portable Colorimeter Using TCS 3200 Color Sensor," in *2021 Asian Conference on Innovation in Technology (ASIANCON)*, Aug. 2021, pp. 1–5, doi: 10.1109/ASIANCON51346.2021.9544866.

[11] M. S. Surbakti *et al.*, "Development of Arduino Uno-Based TCS3200 Color Sensor and Its Application on the Determination of Rhodamine B Level in Syrup," *Indones. J. Chem.*, vol. 22, no. 1, p. 630, Apr. 2022, doi: 10.22146/ijc.69214.

[12] Q.-K. Huynh, C. N. Nguyen, N. P. L. Tran, N. H. P. Vo, T. T. Huynh, and V. C. Nguyen, "Evaluating the optimal working parameters of the color sensor TCS3200 in the fresh chili destemming system," *Can Tho Univ. J. Sci.*, vol. 14, no. 1, pp. 35–42, Mar. 2022, doi: 10.22144/ctu.jen.2022.004.

[13] P. Myland, S. Babilon, and T. Q. Khanh, "Tackling Heterogeneous Color Registration: Binning Color Sensors," *Sensors*, vol. 21, no. 9, p. 2950, Apr. 2021, doi: 10.3390/s21092950.

[14] K. Thoriq Al-Azis, A. Ma'arif, S. Sunardi, F. Nuraisyah, and A. Rusdiarna Indrapraja, "Glucose level detection system in glucose solution using TCS3200 sensor with If-Else method," *Ilk. J. Ilm.*, vol. 13, no. 2, pp. 110–116, Aug. 2021, doi: 10.33096/ilkom.v13i2.733.110-116.

[15] K. K. M. Rahman, M. M. Subashini, M. Nasor, and A. Tawfik, "Development of bio-shields for Arduino Uno," in *2018 Advances in Science and Engineering Technology International Conferences (ASET)*, Feb. 2018, pp. 1–5, doi: 10.1109/ICASET.2018.8376901.

[16] C. Karmokar, J. Hasan, S. Arefin Khan, and M. I. Ibne Alam, "Arduino UNO based Smart Irrigation System using GSM Module, Soil Moisture Sensor, Sun Tracking System and Inverter," in *2018 International Conference on Innovations in Science, Engineering and Technology (ICISET)*, Oct. 2018, pp. 98–101, doi: 10.1109/ICISET.2018.8745597.

[17] M. Rivai, F. Budiman, D. Purwanto, and J. Simamora, "Meat Freshness Identification System using Gas Sensor Array and Color Sensor in Conjunction with Neural Network Pattern Recognition," *J. Theor. Appl. Inf. Technol.*, vol. 96, no. 12, pp. 3861–3872, 2018.

[18] S. Sheeba Rani, J. Janet, K. Ramya, and V. Gomathy, "IoT based climate prediction using ANN for green networking," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 993, no. 1, p. 012090, Dec. 2020, doi: 10.1088/1757-899X/993/1/012090.

[19] W. Kim and S. Kim, "ANN design of multiple open-switch fault diagnosis for three-phase PWM converters," *IET Power Electron.*, vol. 13, no. 19, pp. 4490–4497, Dec. 2020, doi: 10.1049/iet-pel.2020.0795.

[20] W. Jiang, Z. Gong, J. Zhan, Z. He, and W. Pan, "A Low-Cost Image Encryption Method to Prevent Model Stealing of Deep Neural Network," *J. Circuits, Syst. Comput.*, vol. 29, no. 16, p. 2050252, Dec. 2020, doi: 10.1142/S0218126620502527.