FOODSCITECH

Food Science and Technology Journal

TABLE OF CONTENTS

FOODSCITECH
Food Science and Technology Journal

Formulation Optimisation Of Rolled Pancake With Red Dragon Fruit's Skin Using Response Surface Methodology

Anni Faridah[1], Rahmi Holinesti[1,] Minda Azhar[2], Nurqadri Efriensis[3]

[1]Faculty of Tourism and Hospitality, Padang State University
[2]Faculty of Mathematics, Natural Sciences, Padang State University
[3]Family Welfare Study Program
Email : faridah.anni@gmail.com

ABSTRACT

Kue Dadar (lit. pancake) is a green-coloured Indonesian cake, but in recent years it saw the colouring of the pancake is mainly using synthetic colouring. This type of colouring can be substituted with natural colourings such as Betalain, gathered from the skin of the red dragon fruit. The skin is also beneficial for human because it also contains fibre, pectin, and other nutritious contents. This research aims to obtain the formulation of red dragon skin pancake, using the factors of red dragon skin's amount (X_1), egg's amount (X_2), and thick coconut milk's amount (X_3). This research will be conducted through experiments, utilising Response Surface Methodology (RSM) and Central Composite Design (CCD). Data analysis will be assisted by Software Design Expert ver. 7.1. The results of this pancake formulation's optimisation are 89.73 grams of red dragon fruit skin, 39.99 grams of egg, 167.78 ml of thick coconut milk and have a quadratic characteristic. Analysis results of R^2 and Adjusted R^2 by colour and texture response are 0.8720; 0.9500 and 0.9327; 0.9049 respectively. Response values on its optimal condition are 5.47 for colour and 5.62 for texture. Other quality values are 5.00 for shape (good shape), 5.23 for aroma (good smell), and 4.90 (sweet flavour).

Keywords: pancake, red dragon fruit's skin, RSM, formulation

INTRODUCTION

Kue Dadar (lit. pancake) is an Indonesian cake (Faridah, Kasmita, Yulastri, & Yusuf, 2008) , which generally implies a snack that existed in Indonesia. Snacks are usually consumed on party or gratitude ceremonies. It is also can be a tea's companion or a packed meal for daily activities.

Dadar Gulung (lit. rolled pancake) is made from the green-coloured thin and flatly-shaped mixture of flour, coconut milk, and egg, and then rolled and filled with coconut shreds and palm sugar. (Rosida, N., & Windraswara, 2017) Rolled pancake is heated on a pan, making the texture thin, soft, and oily before being added with the variety of filling and rolled. The colouring used is generally still using the synthetic colourings.

Synthetic colourings are unhealthy. According to El-Malky (2015), there are two types of synthetic colourings categorised by the U.S. Food and Drug Administration, which are for food and for drugs. The aim of synthetic food colouring usage is usually to attract consumers because of its affordability and it produces a bright colour (Tripathi, Khanna, & Das, 2007). According to Tang *et al* (2014), synthetic colourings are generally harmful to human. Maximum threshold on this type colouring usage is 300 and 500mg/kg on complex type colouring, according to Codex Alimentarius Commission (CAC). Nugraheni (2014) explains that food-grade synthetic colourings must be limited in number because every synthetic matter that goes into the human body will trigger certain reactions. The usage of synthetic colouring can be substituted with natural colourings. Therefore, the researchers want to use red dragon fruit's skin during the making of rolled pancake as the substitute for synthetic colourings as well as varying the rolled pancake's colour.

Until recently, dragon fruit's skin is still an unused waste material despite its good nutrition contents. It proved by the research of Faridah, Syukri, and Holinesti (2015) that founds antioxidant, antibacterial, rich fibre, and other nutrient contents in the Betalain pigment of the dragon fruit's skin. Furthermore, there is no sign of death, behavioural change, or dead mouse's toxicity after providing the heavy dosage of 48500 mg/kg through oral extracts on the mouse (Faridah, Holinesti, & Syukri, 2015). It becomes a criterion that this particular pigment can be developed into food colouring source (Handayani & Rahmawati, 2012).

Dragon fruit has been widely developed and cultivated around the country, such as in West Sumatra. Another cultivation spots are in Yogyakarta, Malang, Banyuwangi, Bogor, Cilegon, Jember, North Sumatra, Riau, West and Central Kalimantan, and West Nusa Tenggara. The cultivation spots in West Sumatra are located in Padang, Padang Pariaman, Solok, Payakumbuh, and Bukittinggi. The more the cultivating process taking place, the more of its skin is being wasted. Departs from this fact, the skin is very potential to be utilised and developed.

Faridah, Holinesti, *et al*. (2015) stated that red dragon fruit's skin contains Betacyanin, which gives the red natural colour and one of Betalain that potentially becomes natural food colouring and can be an alternative to synthetic colouring that safer for human. Betalain can suppress the oxidation process in the body so it eliminates chances for cancer. Red dragon fruit's skin also contains fibre and pectin that beneficial for the digestive system, preventing obesity, maintaining cholesterol, and very helpful in the forming of food texture that requires jelly forming (Tongkham, Juntasalay, Lasunon, & Sengkhamparn, 2017).

Red dragon fruit's skin utilisation as the natural colouring in the making of rolled pancake is hypothesised to affect the texture, due to the skin tends to form gel because it contains pectin (Tongkham *et al.*, 2017). Utilisation of red dragon fruit's skin in the society or food industry can be used into the making of rolled pancake that proved beneficial for health. This research aims to find optimum formulation for rolled pancake with red dragon fruit's skin.

METHODS

Materials and Tools

This research was conducted at the Culinary Workshop, Department of Family Welfare Science, Faculty of Tourism and Hospitality, State University of Padang. Dragon fruits are gathered from a plantation in Bukittinggi, West Sumatra. Other materials used are for making the rolled pancake, such as flour, coconut milk, sugar, grated coconut, milk, and salt. Tools used in this research are cooking tools specialised for rolled pancake making and a digital scale.

Research Design

Methods that are being used in this research employs RSM (Response Surface Methodology) and CCD (Central Composite Design). This design assisted by the software of Design Expert version 7.1. The basic recipe used as the middle point is the previous research ingredients, which are 75 grams of red dragon fruit's skin, 175 ml of thick coconut milk, and 30 grams of egg. Treatments that conducted on the level above the middle point or maximum dubbed as "code 1" and treatments conducted the level below the middle point or minimum dubbed as "code -1". On this experiment, X_1 variable represents the weight of red dragon fruit's skin, X_2 variable as the number of eggs, and X_3 variable as the amount of thick coconut milk. Table 1 shows the variable level design according to the CCD design. All treatments

consist of 20 formulation processes where each processing conditions follows the experiment design using the software of Design Expert version 7.1.
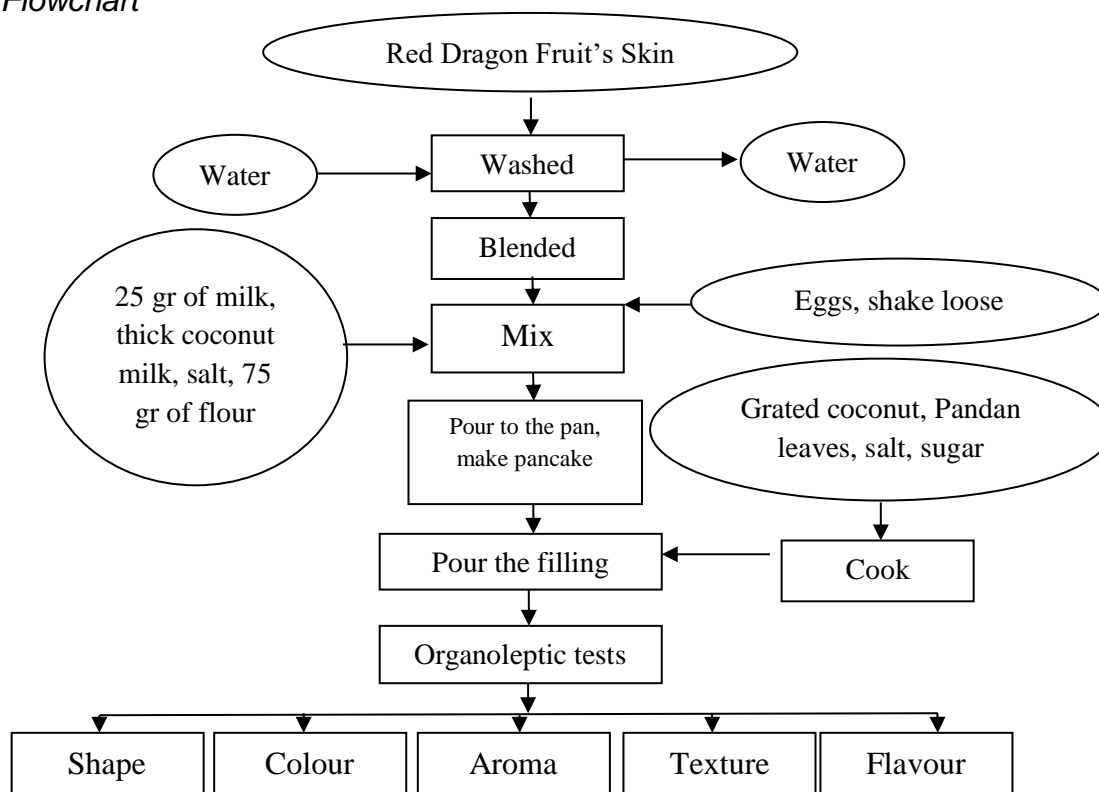
Flowchart

Figure 1. The making process of Rolled Pancake with Red Dragon Fruit's Skin

All ingredients are scaled except the red dragon fruit's skin. The skin is cleaned as washed, have its scale peeled, then sliced thinly and blended until smooth then scaled it afterwards. Mix all ingredients for rolled pancake into the basin (red dragon fruit's skin, flour, milk, eggs, and salt). Pour the coconut milk little by little into the mixture and mix them until it looks homogenous. The mixture then poured into a heated and margarine-smeared pan. After the skin of rolled pancake is cooked, then put it on the cutting board. Afterwards, put the filling on the centre of it and rolled it until the fillings are fully covered (Figure 1).

Data Collection Technique and Analysis

Data collection technique for this research is by giving testing format sheets to 25 semi-trained panellists. According to Arbi (2009), panellists for this research should be 15-25 people. The instrument of this research is the organoleptic test format through a levelled test. The test is employed to determine the quality of different treatments. The organoleptic test is conducted when the panellists are in the condition between hungry and full. Collected data then analysed using the software of Design Expert version 7.1.

RESULT AND DISCUSSION

Formulation optimisation uses the Centre Composite Design through Response Surface Methodology. Factors in this research are the amount of red dragon fruit's skin, thick coconut milk, and egg by colour and texture responses using the organoleptic test. Result data of experiment design and response can be seen in Table 1. This data resulted from the usage of Design Expert version 7.1 software.

Table 1. Centre Composite Design of Second Order, Three Independent Variables, and Two Responses

No	Level			Material's amount (gram)			Response value	
	X_1	X_2	X_3	Red Dragon Fruit's Skin	Thick Coconut Milk	Egg	Colour	Texture
1	0	0	0	75,00	175,00	30,00	4,60	4,80
2	-1	-1	-1	60,00	160,00	15,00	4,40	4,32
3	1	1	-1	90,00	190,00	15,00	4,64	4,64
4	0	0	0	75,00	175,00	30,00	4,36	4,84
5	-1	-1	1	60,00	160,00	45,00	4,00	2,64
6	-1	1	-1	60,00	190,00	15,00	5,40	4,68
7	1	1	1	90,00	190,00	45,00	4,76	4,84
8	0	0	0	75,00	175,00	30,00	4,42	4,40
9	1	-1	1	90,00	160,00	45,00	3,24	5,84
10	0	0	0	75,00	175,00	30,00	4,40	4,36
11	0	0	+α	75,00	175,00	55,23	4,36	4,80
12	-1	1	1	60,00	190,00	45,00	5,00	3,02
13	0	0	0	75,00	175,00	30,00	4,14	4,16
14	0	-α	0	75,00	149,77	30,00	3,02	4,00
15	+α	0	0	100,23	175,00	30,00	3,00	5,88
16	0	0	-α	75,00	175,00	4,77	4,96	4,84
17	0	0	0	75,00	175,00	30,00	4,24	4,20
18	1	-1	-1	90,00	160,00	15,00	3,40	4,92
19	0	+α	0	75,00	200,23	30,00	4,80	3,40
20	-α	0	0	49,77	175,00	30,00	4,64	3,80

Choosing the Appropriate Model

Models gathered can be used to determine the response quality in terms of colour and texture. Value of p response can be seen in Table 2. According to Ameer *et al* (2017), the p-value can be used to evaluate the model's significance through the appropriation of adjusted R^2 and R^2 values close to 1. Model is shown by the ANOVA result, then the target response coefficient will be given to formulating final prediction's equation.

Tabel 2. P-values of the Responses

Diversity source	Value of Colour	p Prob > F Texture
Model	< 0.0001	< 0.0001
A-Red dragon fruit's skin	< 0.0001	< 0.0001
B-Egg	0.0561	0.0343
C-Thick coconut milk	0.1742	< 0.0001
AB	0.0003	0.2178
AC	0.0319	0.2178
BC	0.4080	0.6384
A^2	0.1577	0.0260
B^2	0.1822	0.0156
C^2	0.0034	0.0710
Lack of Fit	0.5427	0.1882
Adjusted R^2	0.8720	0.9049
R^2	0.9327	0.9500

Table 2 reveals that both responses have the model with the p-value of less than 5%. The calculation of the lack of fit test from both responses is larger than 0.05, which are 0.5427 and 0.1882 respectively. Analysis result of R^2 and adjusted R^2 parameters are 0.93 and 0.88 for colour response and 0.95 and 0.9 for texture response (Table 3). According to Ali, Darmadji, and Pranoto (2014), if the p-value is less than 5% ($p<0.05$) and the lack of fit is insignificant ($p<0.05$), then the model is considered as appropriate. Models that suggested on both responses are quadratic.

According to Hendrawan *et al.* (2016) and Ren *et al.* (2018), R2 value showed that the variable affects as much as R2 (in percentage) on response value. Meanwhile, the rest of them are influenced by other factors that did not being inputted in the model. Therefore, for the colour response, 93.27% influenced by three factors aforementioned and the rest (6.73%) influenced by other factors. Meanwhile, the adjusted R2 stated the closeness of the relationship between factor and response.

Surface Responses
Colour

Equation of the quadratic regression model consisted of X1, X2, and X3 variable in the form of polynomial model equation with the equation written as follows:

$$Y_1 = + 4.46 + 0.66\,X_1 - 0.17\,X_2 - 0.11\,X_3 + 0.56\,X_1X_2 - 0.25\,X_1X_3 - 0.087\,X_2X_1 + 0.12\,X_1^2 + 0.11\,X_2^2 - 0.29\,X_3^2 \quad \text{...(1)}$$

Y_1 = colour response value, X_1 = amount of red dragon fruit's skin, X_2 = amount of thick coconut milk, X_3 = number of eggs.

On Figure 2, it can be explained that the factor of red dragon fruit's skin amount mostly affects colour quality, followed by eggs and then thick coconut milk. It is shown by the colour variation (the more the value closer to red, it is more maximum). Figure 2 also showed that the more red dragon fruit's skin and the less thick coconut milk used until a certain point, then the optimum responses are becoming more visible (the graphic colour goes towards red).
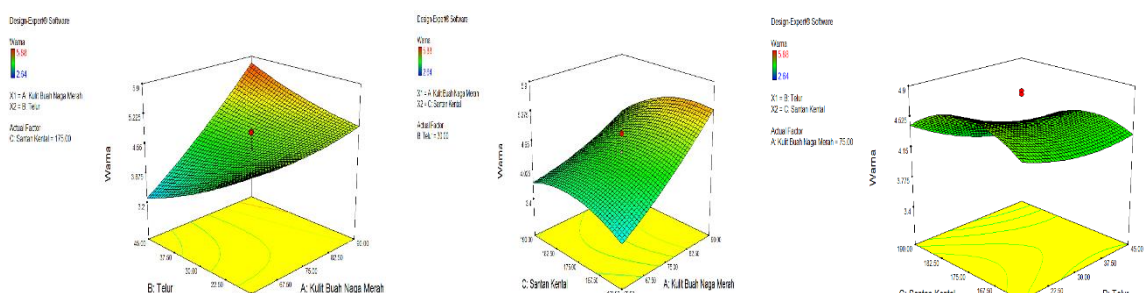

Figure. 2. The relationship between the red dragon fruit's skin amount, eggs, and coconut milk towards the colour quality of the rolled pancake

The relationship between the red dragon fruit's skin and egg is that more red dragon fruit's skin and egg, the higher the rolled pancake's colour value will be. Meanwhile, the relationship between thick coconut milk towards colour is insignificant (no red colour showed in the graphic).

Texture (soft)

The equation of quadratic regression model contains X1, X2, and X3 in the form of order polynomial equation based on data processing using the Design Expert 7.1 as follows:

$$Y_2 = + 4.35 - 0.40\ X_1 - 0.14\ X_2 + 0.57\ X_3 + 0.095\ X_1X_2 + 0.095\ X_1X_3 + 0.035\ X_2X_3 - 0.14\ X_1{}^2 + 0.16\ X_2{}^2 - 0.11\ X_3{}^2 \quad\text{..(2)}$$

Y_2 = texture value response, X_1 = amount of red dragon fruit's skin, X_2 = amount of thick coconut milk, X_3 = number of eggs. The relationship of the three factors can be seen on Figure 3.

Figure 3 reveals that the factor of the amount of red dragon fruit's skin affected the texture's quality. It can be stated in Table 2 (higher amount of red dragon fruit's skin equals higher texture values). Figure 3 also reveals that the less egg number and red dragon fruit's skin used until a certain point, then the optimum response is getting more visible (graphic colour goes towards red).
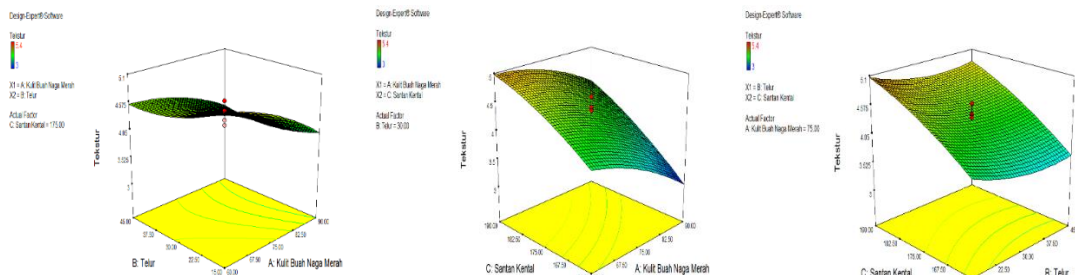

Figure. 3 The relationship between the red dragon fruit's skin amount, eggs, and coconut milk towards the texture quality of the rolled pancake

The relationship between the thick coconut milk and dragon fruit's skin is the more thick coconut milk and less dragon fruit's skin is used on a certain point, then the optimum responses will be more visible (Figure 3). The relationship between egg and thick coconut milk is that more coconut milk means a softer pancake texture.

Optimum Point of Response and Verification

Figure 4 shows the RSM curve from the variable optimum point of the amount of red dragon fruit's skin, thick coconut milk, and egg towards the respons interaction of colour and texture. Optimum point obtained from the computation result of Design Expert version 7.1 is shown on Figure 4.
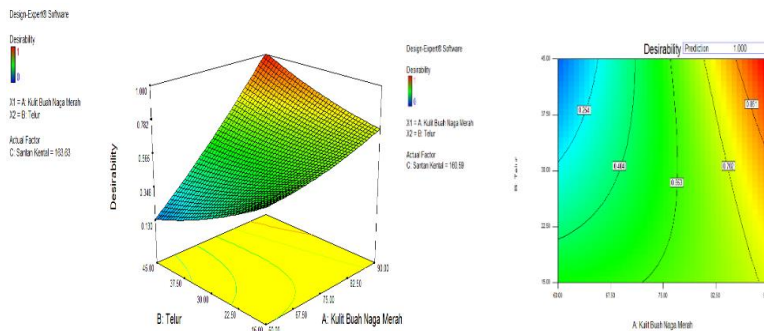

Figure 4. Response surface graphic and contours of variable optimum point towards the interaction of colour and texture response

The true value for a stationary point that obtained from the canonic analysis result is 89.73 for the amount of red dragon fruit's skin, 167.78 for thick coconut milk, and 39.99 for the

egg. The response of colour and texture quality on optimum condition is 5.50 and 5.67 respectively. This condition is the best condition to get the highest value for the quality of colour and texture. The verification step is conducted through comparing response value of the real experiment results with the response value derived from the computation result of Design Expert version 7.1 software, which is 5.47 for colour and 5.62 for texture (see Table 3).

The difference in the percentage value of each response is not too big and the result value of verification almost close to the result from Design Expert 7.1. It is in accordance to Faridah (2016) and Ren *et al* (2018) that indicated the real response value is almost the same with the predicted response value (around 5%).

Tabel 4. Solution of Elected Optimum Point from the Result of Design Expert 7.1 calculation

	Red Dragon Fruit's Skin	Thick Coconut Milk	Egg	Colour	Texture
Prediction	89.73	167.78	39.99	5.50	5.67
Verification	89.73	167.78	39.99	5.47	5.62
Deviation				0.03	0.13
Value Difference %				0.55	0.88

CONCLUSION

Formulation optimisation of the resulted rolled pancake with red dragon fruit's skin is quadratic. Three factors condcuted for this research, which are the amount of red dragon fruit's skin, thick coconut milk, and egg, are confirmed to be influential towards colour and texture response. The optimum condition of those factors are 89.73 for the amount of red dragon fruit's skin, 167.78 for thick coconut milk, and 39.99 for the egg with the response value of 5.47 for colour and 5.62 for texture. Quality value of shape, aroma, and taste on the optimum condition are 5.00 (adequately shaped), 5.23 (good smell), and 4.90 (sweet taste) respectively.

REFERENCES

Ali, D. Y., Darmadji, P., & Pranoto, Y. (2014). OPTIMASI NANOENKAPSULASI ASAP CAIR TEMPURUNG KELAPA DENGAN RESPONSE SURFACE METHODOLOGY DAN KARAKTERISASI NANOKAPSUL. *Jurnal Teknologi Dan Industri Pangan*. https://doi.org/10.6066/jtip.2014.25.1.23

Ameer, K., Bae, S. W., Jo, Y., Lee, H. G., Ameer, A., & Kwon, J. H. (2017). Optimization of microwave-assisted extraction of total extract, stevioside and rebaudioside-A from Stevia rebaudiana (Bertoni) leaves, using response surface methodology (RSM) and artificial neural network (ANN) modelling. *Food Chemistry*. https://doi.org/10.1016/j.foodchem.2017.01.121

Arbi, armien syukri. (2009). Pengenalan Evaluasi Sensori. *Praktikum Evaluasi Sensori*.

El-Malky, W. A. (2015). Nutritional Study of Some Food Coloring Agents on Experimental Rats. *International Journal of Nutrition and Food Sciences*, *3*(6), 538. https://doi.org/10.11648/j.ijnfs.20140306.18

Faridah, A. (2016). Comperation of Porang Flour (morphophallus muelleri) Purification Method : Conventional Maceration (gradient ethanol leaching) and Ultrasonic Maceration Method using Response Surface Methodology. *International Journal on Advanced Science, Engineering and Information Technology*. https://doi.org/10.18517/ijaseit.6.2.769

Faridah, A., Holinesti, R., & Syukri, D. (2015). Betalains from Red Pitaya Peel (Hylocereus polyrhizus): Extraction, Spectrophotometric and HPLC-DAD identification, bioactivity and toxicity screening. *Pakistan Journal of Nutrition*. https://doi.org/10.3923/pjn.2015.976.982

Faridah, A., Kasmita, Yulastri, A., & Yusuf, L. (2008). *Patiseri Jilid 1,2,3*. Jakarta: Direktorat Pembinaan Sekolah Menengah Kejujuran.

Faridah, A., Syukri, D., & Holinesti, R. (2015). Aktifitas Antibakteri Ekstrak Etanol 60% Dan Ekstrak Air Kulit Buah Naga Merah Terhadap Bakteri Staphylococcus Aureus Dan Eschericia Coli. *J.Rekapangan*, *9*(1), 15–18.

Handayani, P. A., & Rahmawati, A. (2012). Pemanfaatan Kulit Buah Naga (Dragon Fruit) Sebagai Pewarna Alami Makanan Pengganti Pewarna Sintetis. *Jurnal Bahan Alam Terbarukan*.

Hendrawan, Y., Susilo, B., Putranto, A. W., Riza, D. F. Al, Maharani, D. M., & Amri, M. N. (2016). Optimasi dengan Algoritma RSM-CCD pada Evaporator Vakum Waterjet dengan Pengendali Suhu Fuzzy pada Pembuatan Permen Susu. *Jurnal Agritech*. https://doi.org/10.22146/agritech.12868

Nugraheni, M. (2014). *Pewarna Alami Sumber dan Aplikasi Makanan dan Kesehatan*. Yogyakarta: Graha Ilmu.

Ren, Z., Qin, T., Liu, X., Luo, Y., Qiu, F., Long, Y., … Huang, Y. (2018). Optimization of Hericium erinaceus polysaccharide-loaded Poly (lactic-co-glycolicacid) nanoparticles by RSM and its absorption in Caco-2 cell monolayers. *International Journal of Biological Macromolecules*. https://doi.org/10.1016/j.ijbiomac.2018.06.169

Rosida, N., & Windraswara, R. (2017). Hygiene Dan Sanitasi Pedagang Jajanan Di Lingkungan Sd/Mi. *Jurnal of Health Education (JHE)Health Education*, *2*(1), 80–85.

Tang, B., Xi, C., Zou, Y., Wang, G., Li, X., Zhang, L., … Zhang, J. (2014). Simultaneous determination of 16 synthetic colorants in hotpot condiment by high performance liquid chromatography. *Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences*. https://doi.org/10.1016/j.jchromb.2014.04.026

Tongkham, N., Juntasalay, B., Lasunon, P., & Sengkhamparn, N. (2017). Dragon fruit peel pectin: Microwave-assisted extraction and fuzzy assessment. *Agriculture and Natural Resources*. https://doi.org/10.1016/j.anres.2017.04.004

Tripathi, M., Khanna, S. K., & Das, M. (2007). Surveillance on use of synthetic colours in eatables vis a vis Prevention of Food Adulteration Act of India. *Food Control*. https://doi.org/10.1016/j.foodcont.2005.09.016