Food Research 8 (Suppl. 4) : 111 - 115 (2024)
Journal homepage: https://www.myfoodresearch.com

FOOD RESEARCH

RESEARCH PAPER

Development of steamed cake using red wine dreg as a natural colourant

Ng, W.W. and *Thed, S.T.

Faculty of Applied Sciences, Tunku Abdul Rahman University of Management and Technology, Jalan Genting Kelang, 53300 Kuala Lumpur, Malaysia

Article history:
Received: 16 August 2023
Received in revised form: 11 October 2024
Accepted: 11 October 2024
Available Online: 3 November 2024

Keywords:
Red yeast rice,
Red wine dreg,
Steamed cake,
Natural colourant

DOI:
https://doi.org/10.26656/fr.2017.8(S4).22

Abstract

Red yeast rice is a fermented rice that acquires its red colour from being cultivated with the yeast *Monascus purpureus*. It is widely used to produce various fermented foods in China, Japan, and East Asia. Red yeast rice has been reported to lower cholesterol, improve digestion, and possess antioxidant activity. Red yeast rice is a main ingredient in Foochow red wine. This study aimed to develop steamed cake by using Foochow red wine dreg as a natural food colourant. The steamed cake was prepared by mixing self-rising flour, sugar, raisins, water, and red wine dreg extract, and then steamed at high heat for 20 mins. The sensory qualities of the steamed cake were evaluated by fifty untrained panellists using a 7-point hedonic scale. The physicochemical properties and antioxidant activity of the product were determined. The overall acceptability score for the steamed cake was 5.80 out of 7 with an acceptance index of 83%. The mean scores for various sensory attributes were: colour (5.56), aroma (5.52), taste (5.72), and texture (5.26). The colour profile of the steamed cake was L* = 64.10±0.34, a* = 11.46±0.37 and b* = 21.94±0.68. The radical scavenging capacity DPPH was 53.47% with a total phenolic content of 2.35 mg GAE/g, and a total flavonoid content of 1.70 mg CE/g. The steamed cake contained 12.55% sugar and alcohol was not detectable. Red wine dreg provides an attractive colour to the cake. In summary, a healthier steamed cake with natural colourant and enhanced antioxidant activity was developed.

1. Introduction

The traditional Chinese steamed cake or "Fa Gao" in Mandarin symbolizes good luck and prosperity and is often used as a religious offering. The steamed cake is usually made from flour, sugar, water, leavening agent and artificial red colouring; and always splits on top which signifies abundance. In recent decades, due to the high demand for natural products by health-conscious consumers, natural food colourants are gaining popularity and interest in the food and beverage sectors. In this study, red wine dreg (a food waste) was used as a natural food colourant in making steamed cake.

Red yeast rice (or red koji in Japanese) is a fermented rice that acquires its red colour from being cultivated with the yeast *Monascus purpureus*. The fully cultured rice is sold in the form of dried grain, wet paste or fine powder. The dried grain can be prepared and eaten in the same manner as white rice or added to other foods. Red yeast rice is used to colour a wide variety of food products, including fermented bean curd, red rice vinegar, barbecued meat (char siu), Peking duck and pastries. It is also traditionally used in the production of several types of Chinese wine, Japanese sake (akaisake), and Korean rice wine (hongju), imparting a reddish colour to these wines. Although used mainly for its colour in cuisine, red yeast rice imparts a subtle but pleasant taste to food. Red yeast rice has been reported to lower cholesterol, improve digestion, and possess anti-inflammatory, hypolipidemic, antioxidant and anti-microbial activities (Akihisa *et al*., 2005; Tuli *et al*., 2014). Red yeast rice is a main ingredient in local Foochow red wine.

This study aimed to develop steamed cake by using Foochow red wine dreg as a functional ingredient to impart colour and aromatic fragrance to the product; to conduct a sensory evaluation of the steamed cake and to determine the physicochemical properties of the product.

2. Materials and methods

2.1 Preparation of steamed cake

The formulation of the steamed cake: 45.5% self-

*Corresponding author.
Email: *thedst@tarc.edu.my*

eISSN: 2550-2166 /
Published by Rynnye Lyan Resources

raising flour, 14.5% castor sugar, 25.0% of water, 10.0% natural food colourant (extract from Foochow red wine dreg), 3.6% sunflower oil, 0.7% baking powder, and 0.7% of raisin. All ingredients were weighed separately. The sieved self-raising flour and other dry ingredients were pre-mixed in a big bowl. Distilled water was used to extract the *Monascus* pigments from red wine dreg. Red yeast rice extract and water were added to the dry ingredients and mixed well. Next, sunflower oil was added to smoothen the batter. The batter was poured into moulds with paper cups, raisins were added and then steamed at high heat for 20 mins.

2.2 Sensory evaluation

Sensory attributes (texture, colour, aroma, taste, and overall acceptability) of the steamed cake samples were evaluated by fifty untrained panellists (age 19-40, male 34% and female 66%) using a 7-point hedonic scale (1: dislike very much to 7: like very much). A briefing on the evaluation procedure and sensory attributes was given to the panellists. A 7-point hedonic scale is commonly used for affective sensory evaluation to determine the acceptability of a product. The Acceptance Index (AI) of the steamed cake was calculated using the formula: AI = (Mean overall acceptability score/7) × 100.

2.3 Physicochemical analysis

The proximate composition of the steamed cake sample was carried out in triplicate according to American Association of Cereal Chemists (AACC) approved methods (AACC International, 2000). The colour profile of the steamed cake was measured in triplicate by using the Lovibond spectrocolourimeter. Calibration was conducted on the spectrocolourimeter before analysis. The values of L*, a*and b* of the sample were recorded.

2.4 Extraction of sample for antioxidant assay

The steamed cake was freeze-dried to obtain its powder form. A 5 g of the freeze-dried sample was extracted with 45 mL of 10% methanol by refluxing for 2 hrs, then cooled to room temperature. The extracted sample was centrifuged at 4°C for 15 mins at 5500 rpm. The supernatant was filtered using Whatman No. 1 filter paper. Methanol was removed by a rotary evaporator. The sample extract was screw-capped, wrapped with aluminum foil and kept in the refrigerator until further analysis.

2.4.1 DPPH test

The DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity was determined according to the methodology described by Lu *et al*. (2014). Briefly, 0.1 mL of sample extract was mixed with 3.9 mL of 0.06 mM DPPH solution in a test tube. The mixture was wrapped with aluminum foil, and incubated in a water bath (30°C, 30 mins). After incubation, the absorbance of the sample was read at 517 nm using a UV-Vis spectrophotometer against a prepared blank. The Radical scavenging activity (%) was calculated using the equation below:

$$\text{DPPH scavenging activity (\%)} = \frac{AB-AA}{AB} \times 100\%$$

Where AB = Absorbance of blank sample and AA = Absorbance of sample

2.4.2 Determination of total phenolic content

A series of gallic acid standard solutions with different concentrations were prepared. A 0.5 mL of each standard solution was pipetted into a test tube and mixed with 2.5 mL of 10% Folic-Ciocalteu reagent. The mixture was incubated at 37°C for 5 mins and then 2.0 mL of 7% sodium carbonate solution was added into each test tube before incubation at 37°C for 30 mins. Then, the absorbance of each standard solution was read at 765nm using a UV-Vis spectrophotometer. A calibration curve was prepared by plotting the absorbance at 765 nm versus different concentrations of Gallic acid solution. For the total phenolic content (TPC) determination of the sample, 0.5 mL of the standard solution was replaced by 0.5 mL of diluted sample extract. The concentration of gallic acid equivalent (GAE) was calculated by using the formula below:

$$\text{TPC (mg GAE/g)} = \frac{\text{R (mg/mL)} \times \text{Total Volume of sample extract (mL)} \times \text{Dilution factor}}{\text{Weight of sample (g)} \times \text{Volume of sample extract used (mL)}}$$

2.4.3 Determination of total flavonoid content

Catechin standard solutions with different concentrations were prepared. A 1.0 mL aliquot of each standard solution was diluted with 4.0 mL distilled water in a test tube. A 0.3 mL of 5% sodium nitrite solution was added to each mixture and incubated for 5 mins after shaking. Then, 0.3 mL of 10% aluminum chloride was added to each tube and incubated for 6 mins and vortexed. Next, 2.0 mL of 1.0 M sodium hydroxide and 2.4 mL deionized water were added and incubated for 15 mins and read at 510 nm using a UV-Vis spectrophotometer. A calibration curve was prepared by plotting the absorbance versus different concentrations of catechin solution. For the total flavonoid content (TFC) determination of the sample, the 1.0 mL of the standard solution was replaced by 1.0 mL of diluted sample extract. The TFC values were calculated by using the formula below:

$$\text{TFC (mg CE/g)} = \frac{\text{R (ppm)} \times \text{Total Volume of sample extract (mL)} \times \text{Dilution factor}}{\text{Weight of sample (g)} \times \text{Volume of sample extract used (mL)} \times 1000}$$

https://doi.org/10.26656/fr.2017.8(S4).22

2.5 Determination of total sugar content by Dubois method

A 1000 µL of diluted extract was pipetted into test tube. Then, 1000 µL of 5% phenol solution was added into the test tube, followed by 5.0 mL concentrated sulphuric acid and the mixture was shaken well in the fume hood. The absorbance of the sample and blank were measured at 490 nm by spectrophotometer after 30 mins. A standard calibration curve was established using different concentrations of standard glucose solution. The total sugar content of the sample was calculated using the following formula:

$$\text{Total sugar content} = R \times \frac{TV}{SV} \times \frac{DF}{Wt}$$

Where R = Sugar content obtained from standard curve, TV = Sample volume, SV = Volume of sample used for spectrophotometric measurement, Wt = Sample weight and DF = Dilution factor

2.6 Determination of alcohol

The alcohol content was determined by dichromate oxidation and redox titration according to the methodology described by Walding (2023).

2.7 Statistical analysis

All analyses were done in triplicate and the measurements were reported as the mean ± standard deviation (SD). The data were analyzed by t-test and Pearson correlation test. The significance was defined at $p<0.05$. The data analysis was performed using IBM SPSS software version 25.0.

3. Results and discussion

3.1 Sensory evaluation

The sensory attributes of the steamed cake were evaluated by fifty untrained panellists using a 7-point hedonic scale. Table 1 displays the mean scores of various sensory attributes of the steamed cake. The mean overall acceptability score of the steamed cake was 5.80 out of 7 with an acceptance index of 83%. Most of the sensory attribute scores are inclined to 6, corresponding to "like moderately" on the scale. The texture of the steamed cake has the lowest score of 5.26, indicating that some panellists are not in favour of the texture of the product. Steamed cake with just-about-right moistness and fluffiness is desirable. A slight increase in oil and baking powder shall further improve its moistness and fluffiness, respectively. The scores for taste and aroma were 5.72 and 5.52, respectively, suggesting that most panellists liked the taste and aroma of the steamed cake. This could be due to the sweet taste and aromatic fragrance of the red wine dreg extract.

Table 1. Mean score of sensory attributes of the steamed cake (n = 50).

Sensory attribute	Mean score
Colour	5.56±1.01
Aroma	5.52±1.09
Taste	5.72±1.09
Texture	5.26±1.31
Overall acceptability	5.80±0.99

The percentage distributions of sensory scores are shown in Figures 1 and 2. Based on the evaluation of 50 panellists, a total of 74% of the panellists liked the texture of the steamed cake; 86% liked the colour; 82% liked the aroma; and 84% liked the taste of the steamed cake. Overall, 88% of the panellists liked the steamed cake with Foochow red wine dreg extract which plays a role in imparting an attractive peach-pink colour and enhancing the overall taste and aroma of the product.

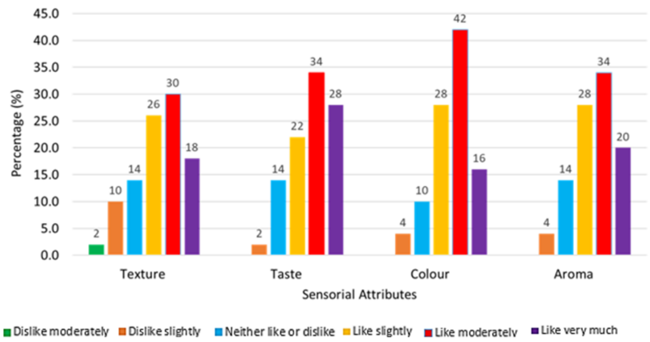

Figure 1. Percentage distribution of sensory scores of the steamed cake.

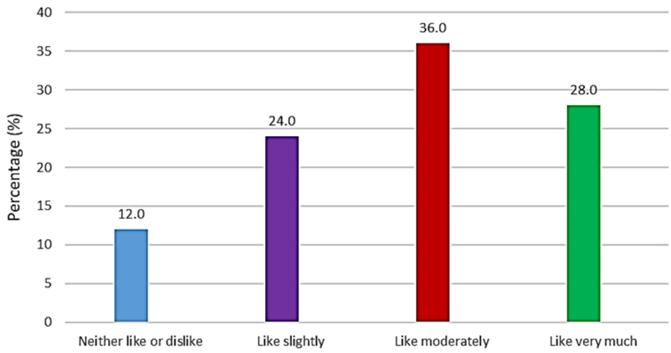

Figure 2. Percentage distribution of overall acceptability scores.

The correlation between overall acceptability and various sensory attributes was analyzed using the Pearson correlation test (Table 2). Different sensory factors affect the acceptability of the product to a different extent. The overall acceptability of the product is affected by taste, texture, aroma, and colour in descending order of significance. An independent t-test was also run to compare the mean overall acceptability scores between male and female panellists. The result shows that there is no significant difference ($p>0.05$) between males and females in terms of their overall acceptability score, suggesting that the steamed cake has

https://doi.org/10.26656/fr.2017.8(S4).22

a potential market for both genders.

Table 2. Pearson correlation coefficient between overall acceptability and various sensory attributes.

Overall acceptability*attribute	r-value	Correlation
Overall acceptability*taste	0.875	Strong correlation
Overall acceptability*texture	0.736	Moderate correlation
Overall acceptability*aroma	0.702	Moderate correlation
Overall acceptability*colour	0.684	Moderate correlation

3.2 Physicochemical analysis

The proximate composition of the Chinese steamed cake is shown in Table 3. The steamed cake contained 23.43% carbohydrate, 6.59% protein, 4.89% fat, 3.03% crude fibre, and 1.95% ash content. The carbohydrate was mainly contributed from flour and the added sugar and raisins. The added raisin also served as a source of fibre. The steamed cake contained 12.55% sugar and alcohol was not detectable.

Table 3. Physicochemical properties of the steamed cake.

Chemical Composition	Amount
Protein (%)	6.59±0.05
Fat (%)	4.89±0.01
Carbohydrate (%)	23.43±0.03
Total sugar (%)	12.55±0.02
Crude fibre (%)	3.03±0.13
Ash (%)	1.95±0.01
Antioxidant Analysis	
DPPH radical scavenging activity (%)	53.47±0.03
TPC (mg GAE/g)	2.35±0.02
TFC (mg CE/g)	1.70±0.04
Colour	
L*	64.10±0.34
a*	11.46±0.37
b*	21.94±0.68

Values are presented mean±SD (n = 3).

The colour profile of the steamed cake is shown in Table 3. The L* value represents lightness, the higher the L* value the brighter the colour; and positive values of a* and b* represent red and yellow, respectively. The steamed cake with red wine dreg extract is peach pink in colour. The *Monascus* pigments in red wine dreg are primarily polyketides (Fukami *et al*., 2021). Kim (2013) reported that the colour of red yeast rice had strong heat stability in sausages, and the optimal temperature at which the colour was most stable was 100°C or below. The stability of the bio-pigment can be enhanced by encapsulation technique (Priatni, 2015) or in the presence of sodium chloride (Velmurugan *et al*., 2011).

The steamed cake demonstrated a DPPH radical scavenging capacity of 53.47% with a total phenolic content of 2.35 mg GAE/g, and a total flavonoid content of 1.70 mg CE/g (Table 3). Antioxidants present in red yeast rice include flavonoids, polyphenols, carotenoids, alkaloids, and vitamins (Chairote et al., 2009). Aniya *et al*. (1999) performed screening on 13 species of *Monascus* and reported that fermentation by *Monascus purpureus* showed the highest antioxidant activity. The compounds in red yeast rice that can act as antioxidants are dimerumic acid (Aniya et al., 2000), dihydromonacolin-MV, γ-aminobutyric acid (GABA), ankaflavin and monascin (Dhale *et al*., 2007). Four other phenolic compounds were isolated from red yeast rice by Ji *et al*. (2018). The four compounds were identified as 2 -methyl-5-(2'R-methyl-4'-hydroxy-butyl)-cinnamic acid, 5-(2'-hydroxy-6'-methyl phenyl)-3-methylfuran-2-carboxylic acid, daidzein, and genistein.

Liu *et al.* (2022) studied the antioxidant activity of oligosaccharides from red yeast rice. Low molecular weight oligosaccharides predominantly glucose, mannose, galactose, and glucosamine were isolated from red yeast rice and showed antioxidant effects with DPPH and ABTS radicals scavenging ability of 34.29% and 90.41%, respectively. ABTS assay showed a relatively higher value because $ABTS^{•+}$ radical cations are soluble in both water and organic solvents, which enables the antioxidant capacity of both hydrophilic and lipophilic compounds to be determined. In this study, DPPH assay was used for the determination of antioxidant activity. Polar solvent methanol was used to extract mainly the hydrophilic phenolics, and possibly flavonoid glycosides in the red yeast rice steamed cake.

4. Conclusion

Natural pigments are an important alternative to potentially harmful synthetic dyes. A steamed cake with good sensory quality was developed by using Foochow red wine dreg as a natural colourant. The product with a relatively high antioxidant activity provides a healthier version of the traditional Chinese steamed cake. Utilization of food waste i.e., red wine dreg, as a functional ingredient for food production, has some significant implications for food waste reduction, environmental protection, and economic gains. The project aligns with the global sustainable development goal (SDG 3) – promote good health and well-being of consumers.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgments

This study was funded by Tunku Abdul Rahman University of Management and Technology.

References

American Association of Cereal Chemists (AACC) International. (2000). Approved Methods of the American Association of Cereal Chemists (Method 66-50). 10th ed. St. Paul, USA: AACC International.

Akihisa, T., Tokuda, H., Ukiya, M., Kiyota, A., Yasukawa, K., Sakamoto, N., Kimura, Y., Suzuki, T., Takayasu, J. and Nishino, H. (2005). Anti-tumour -initiating effects of monascin, an azaphilonoid pigment from the extract of Monascus pilosus fermented rice (red-mold rice), *Chemistry and Biodiversity*, 2(10), 1305–1309. https://doi.org/10.1002/cbdv.200590101

Aniya, Y., Yokomakura, T., Yonamine, M., Shimada, K., Nagamine, T., Shimabukuro, M. and Gibo, H. (1999). Screening of antioxidant action of various molds and protection of *Monascus anka* against experimentally induced liver injuries of rats. *General Pharmacology*, 32(2), 225-231. https://doi.org/10.1016/S0306-3623(98)00183-9

Aniya, Y., Ohtani, I.I., Higa, T., Miyagi, C., Gibo, H., Shimabukuro, M., Nakanishi, H. and Taira, J. (2000). Dimerumic acid as an antioxidant of the mold, *Monascus anka*. *Free Radical Biology and Medicine*, 28(6), 999-1004. https://doi.org/10.1016/S0891-5849(00)00188-X

Chairote, E., Chairote, G. and Lumyong, S. (2009). Red yeast rice prepared from Thai glutinous rice and the antioxidant activities. *Chiang Mai Journal of Science*, 36(1), 42-49.

Dhale, M.A., Divakar, S., Kumar, S.U. and Vijayalakshmi, G. (2007). Isolation and characterization of dihydromonacolin-MV from *Monascus purpureus* for antioxidant properties. *Applied Microbiology and Biotechnology*, 73, 1197-1202. https://doi.org/10.1007/s00253-006-0578-0

Fukami, H., Higa, Y., Hisano, T., Asano, K., Hirata, T. and Nishibe, S. (2021). A review of red yeast rice, a traditional fermented food in Japan and East Asia: Its characteristic ingredients and application in the maintenance and improvement of health in lipid metabolism and the circulatory system. *Molecules*, 26(6), 1619. https://doi.org/10.3390/molecules26061619

Ji, Y.B., Xu, F., Liu, B.Y., Wei, Q., Guo, Y.Z., Dong, Y., Sun, Y. and Hu, Y.C. (2018). Trace phenolic compounds from red yeast rice. *China Journal of Chinese Materia Medica*, 43(4), 755-759.

Kim, D.W. (2013). Quality characteristics of sausage added red yeast rice. *Korean Journal of Food Preservation.* 20(6), 805-809. https://doi.org/10.11002/kjfp.2013.20.6.805

Liu, K., Xie, L., Gu, H., Luo, J. and Li, X. (2022). Ultrasonic extraction, structural characterization, and antioxidant activity of oligosaccharides from red yeast rice. *Food Science and Nutrition,* 10(1), 204-217. https://doi.org/10.1002/fsn3.2660

Lu, X.-H., Sun, D.-Q., Wu, Q.-S, Liu, S.-H. and Sun, G.-M. (2014). Physico-chemical properties, antioxidant activity and mineral contents of pineapple genotypes grown in China. *Molecules*, 19(6), 8518-8532. https://doi.org/10.3390/molecules19068518

Priatni, S. (2015). Encapsulation and stability study of *Monascus* fermented rice extract *Procedia Chemistry*, 17, 189-193. https://doi.org/10.1016/j.proche.2015.12.118

Tuli, H., Chaudhary, P., Beniwal, V. and Sharma, A. (2014). Microbial pigments as natural colour sources: current trends and future perspectives. *Journal of Food Science and Technology,* 52(8), 4669-4678. https://doi.org/10.1007/s13197-014-1601-6

Velmurugan, P., Hur, H., Balachandar, V., Kamala-Kannan, S., Lee, K.J., Lee, S.M., Chae, J.C., Shea, P.J. and Oh, B.T. (2011). *Monascus* pigment production by solid-state fermentation with corn cob substrate. *Journal of Bioscience and Bioengineering,* 112(6), 590–594. https://doi.org/10.1016/j.jbiosc.2011.08.009

Walding, R. (2023). Estimation of alcohol content in wine by dichromate oxidation followed by redox titration. Retrieved from Senior Chem website: https://seniorchem.com/4.%20Alcohol-Content-by-Dichromate-Oxidation-and-Redox-Titration2.pdf

https://doi.org/10.26656/fr.2017.8(S4).22