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Effect of Using Red Rice Fermented by *Monascus ruber* AUMC 4066 as Replacement of Wheat Flour in Sponge Cake

Soumia M. Darwish

Department of Food Science and Technology, Faculty of Agriculture, Assiut University, Egypt

Abstract: Preparation of sponge cake using red yeast rice (RYR) fermented by *Monascus ruber* AUMC 4066 as partial substitution of wheat flour was investigated. Formulations of sponge cake batter containing flour blends of wheat flour and RYR at five mixing ratios (100:0, 70:30, 50:50, 30:70 and 0:100) were studied. The physical characteristics, color quality, texture profile of cake batters and physicochemical, textural and sensory quality of the sponge cake supplemented were evaluated. The moisture, viscosity, specific gravity in cake batter increased with increased red yeast rice flour levels. Moisture, carbohydrate, fiber, ash, crumb *L* value, hardness, adhesiveness, total phenols and antioxidant property in baked sponge cake increased with increased red yeast rice flour levels. However, volume of cake, color of crust *L, a*, *b* color of crumb *a, b* values, springiness and resilience of baked sponge cakes showed decreased with increased red yeast rice flour levels. The results of sensory evaluation indicated that the cake with 70 % RYR flour was rated the most acceptable.

Key words: Sponge Cake · *Monascus ruber* · Red Yeast Rice · Antioxidant Activity · Sensory Evaluation

INTRODUCTION

The developing world considerable rice is a main cereal crop. Even though white rice commonly consumed, there are several different cultivars of rice that have color pigments, such as black rice, red rice and brown rice. Their name refers to the kernel color (red purple, or black) which is formed by deposits of anthocyanins in different layers of the pericarp, seed coat and aleurone [1]. The Monascus group includes *M. anka, M. ruber* and a strain of *M. ruber* known as *M. purpureus,* among others (Ruber and Puerpureus are the Latin words for red and purple, respectively.) these fungi can produce an intense red pigment as well as other metabolic byproducts cultivated on cooked non glutinous rice [2-4].

Food product from red yeast rice contains unsaturated fatty acids has the ability of reducing the level of serum lipids in the blood of animals and humans [5-7]. Red pigment maintains normal cholesterol levels, supports healthy circulatory, cardiovascular and immune systems, liver function, provides antioxidant and improves digestion and blood circulation for thousands of years [8, 9]. Also red yeast rice has antioxidant activity and many health effects on diabetes, cancer and cardiovascular diseases, which are attributed to bioactive compounds, such as phenolic compounds, goryzanols, tocopherols, tocotrienols, phytic acid, anthocyanins and dietary fiber [10-16]. The phytochemicals in pigmented rice, such as phenolics are related with reducing the risks of developing chronic diseases, such as diabetes, obesity, cancer and cardiovascular disease [17]. The phenolic acids are mainly present in the fermented red yeast rice [18, 19] and demonstrated positive effects on several human chronic diseases, such as obesity, diabetes, cardiovascular and cancer [20, 21].

Two radical scavenging assays ABTS (Ferric reducing antioxidant power) and FRAP (Free radical scavenging power) were carried out in order to determine the total antioxidant capacities [22, 23]. Cake products are widely consumed all over the world. The information about the effect of fermented red yeast rice by *Monascus ruber* AUMC 4066 on the physicochemical, antioxidant and sensory evaluation of cake products is limited. The aim of study were utilization of the benefits of fermented red yeast rice to develop a novel formula for cake production with red yeast rice & manufacture sponge cakes with 100% (w/w) replacement of wheat flour with red yeast rice flour and determination of the physicochemical, antioxidant and sensory quality characteristics of red yeast rice sponge cakes.

Corresponding Author: Soumia M. Darwish, Department of Food Science and Technology, Faculty of Agriculture, Assiut University, Egypt. Tel: +201112325474, Fax: (+20) 88-2331384, E-mail: soumiadarwish123@hotmail.com.

MATERIALS AND METHODS

Materials: Red yeast rice was prepared according to Darwish *et al.* [24]. Sucrose, sodium chloride, sunflower oil, fresh eggs and nonfat dry milk were purchased from the local market in Assiut, Egypt.

Preparation of Sponge Cake: The control of sponge cake was prepared according to Mau *et al.* [25]. The control sponge cake contained 174 g wheat flour (WF), 3 g red yeast rice flour (RYRF), 130 g sucrose, 2 g sodium chloride, 87 g sunflower oil, 87 g egg yolk, 114 g distilled water and 13 g nonfat dry milk. The control cake foam contained egg white (174 g), sucrose (104 g). The RYR was used to substitute 30, 50, 70 and 100% (w/w) of wheat flour to make various sponge cakes, assigned as RYR30, RYR50, RYR70 and RYR 100%, respectively. After baking, the baked cakes were allowed to cool for 2 h at 25-27°C and were removed from pans. Baked sponge cakes were packed in polypropylene bags for analyses of physicochemical, antioxidant and sensory characteristics.

Proximate Composition of Sponge Cake: The proximate compositions of sponge cakes, including moisture, protein, fat, ash, crude fiber and carbohydrate were determined according to AOAC [26].

Physical Characteristics of Sponge Cake Batters: The moisture of cake batters was determined according to AOAC [26]. The 400 mL of cake batter was poured into a 500 mL beaker and its viscosity was measured at 200 rpm with a spindle 7 on a programmable rheometer (Brookfield, DV-III Ultra) [27]. The specific gravity of cake batters was determined according to AOAC [26]. The clean, dry pycnometer was calibrated by determining its weight and the weight of recently boiled water contained in it at 30°C. Temperature of the cake dough was adjusted to about 30°C and the pycnometer was filled with it. Also, the temperature of the filled pycnometer was adjusted to 30°C. Excess dough was removed and the pycnometer was weighed. The tare weight of the pycnometer was subtracted from the filled weight. The specific gravity of the dough is the quotient obtained by dividing the weight of the dough contained in the pycnometer by the weight of water contained in it.

Physical Characteristics of Baked Sponge Cake: Weight, volume and specific volume of sponge cakes were determined as described in AACC International [28]. Water activity of sponge cakes was determined according to Patricia and Theodore [29]. Hunter color parameter (L, a & b) of cake blends were followed up using Tristimulus Color Analyzer (Hunter, Lab Scan XE, Reston, Virginia) with standard white tile. Texture profile analysis (TPA) parameters (hardness, adhesiveness, springiness, resilience) of cake samples were measured objectively by using a texture analyzer TA-CT3 (Brookfield, USA) and were analyzed following the method used in AACC International [28].

Determination of Total Phenols and Antioxidant Activity of Sponge Cake Extracts: Twenty grams of cake were extracted using petroleum ether, tetrahydrofuran and methanol in succession using soxhlet apparatus according to the methods of Roopalatha and Nair [30] with some modifications. Each extract obtained following extraction step was filtered using filter paper Whatman No 1, dried using rotary evaporator and the yield of each extract thus obtained was recorded. Different extracts were reconstituted in 10 mL dimethylsulfoxide (DMSO) and stored under nitrogen at -30°C till further use. The total phenolic content was determined according to the Folin-Ciocalteu procedure [31]. Briefly, the extract (100 µL) was transferred into a test tube and the volume adjusted to 3.5 mL with distilled water and oxidized with the addition of 250 µL of Folin-Ciocalteau reagent. After 5 min, the mixture was neutralized with 1.25 mL of 20% aqueous sodium carbonate (Na_2CO_3) solution. After 40 min, the absorbance was measured at 725 nm against the solvent blank. The total phenolic content was determined by means of a calibration curve prepared with gallic acid and expressed as µg of gallic acid equivalent (mg GAE) per g of sample. Free radical scavenging capacity of extracts was determined using the stable 2, 2-diphenyl-1-picrylhdrazyel (DPPH) according to Hwang and Do Thi [32]. The final concentration was 200 µM for DPPH and the final reaction volume was 3.0 mL. The absorbance was measured at 517 nm against a blank of pure methanol after 60 min of incubation in a dark condition. Percent inhibition of the DPPH free radical was calculated by the following equation: inhibition (%) = $100 \times [(A_{control}-A_{sample})/A_{control}]$. $A_{control}$ is the absorbance of the control reaction (containing all reagents except the test compound). A_{sample} is the absorbance with the test compound. The standard curve was prepared using Trolox. Results were expressed as µg Trolox equivalents (TE)/g sample. The stock solutions of ABTS (2, 2-azinobis (3-ethyelbenothiazoline-6-sulfonic acid) reagent was prepared according to Hwang and Do Thi [32] by reacting equal quantities of a 7 mM aqueous solution of ABTS with 2.45 mM potassium persulfate for 16 h at room temperature (25°C) in the dark. The working solution was then prepared by diluting 1 mL of ABTS solution with 60 mL of ethanol: water (50:50 v/v) to obtain an absorbance of 1.0± 0.02 units at 734 nm using the spectrophotometer. Extracts (50 µL) were allowed to react with 4.95 mL of the ABTS solution for 1 h in a dark condition. Then the absorbance was taken at 734 nm using the spectrophotometer. The standard curve was prepared using Trolox. Results were expressed as µg Trolox equivalents (TE)/g sample). The Ferric reducing activity power (FRAP) assay was done according to Hwang and Do Thi [32]. The stock solutions included 300 mM acetate buffer [3.1 g sodium acetate ($C_2H_3NaO_2.3H_2O$) and 16 mL glacial acetic acid ($C_2H_4O_2$), pH 3.6], 10 mM TPTZ solution in 40 mM HCl and 20 mM ferric chloride ($FeCl_3.6H_2O$) solution. The fresh working solution was prepared by mixing 25 mL acetate buffer, 2.5 mL TPTZ solution and 2.5 mL $FeCl_3.6H_2O$ solution and then warmed at 37°C before using. Extracts (50 µL) were allowed to react with 3.95 mL of the FRAP solution for 30 min in the dark condition. Readings of the colored product [ferrous tripyridyltriazine complex] were then taken at 593 nm. The standard curve was prepared using Trolox and the results were expressed as µg Trolox equivalent (TE/g sample).

Sensory Evaluation: Sponge cake controls and RYR sponge cake blender formulas were assessed by 8 panelists using a sensory rating scale of 1 (poor) to 10 (excellent) for some sensory parameters (the color, odor, texture, flavor and overall acceptability), as described by Bodyfelt *et al.* [33].

Statistical Analysis: The results were analyzed using one-way ANOVA (IBM SPSS.21statistical software). A p value <0.05 was considered statistically significant for all analysis.

RESULTS AND DISCUSSION

Proximate Composition of Sponge Cake: The moisture contents varied between 28.10 and 30.91%. The moisture contents of sponge cake RYR blends increased with increased red yeast rice flour level (Table 1). The increased in the moisture contents may be due to the moisture content in the RYR (30.91%). There were significant difference ($p \leq 0.05$) of moisture contents amongst the blend sponge cake RYR samples except between RYR 30 and RYR 50 there were no significantly different. The protein and fat contents varied between 6.99 to 5.94 % and 15.25 to 12.68 %, respectively. The protein and fat contents of sponge cake RYR blends decreased with increased red yeast rice flour level that may be due to the higher content wheat flour from protein and fat than those of rice flour. There were significant difference ($p \leq 0.05$) of protein and fat amongst the blend sponge cake RYR samples. Ash contents were significantly different amongst the sponge cake RYR blends to have highest ash contents was 1.03% with RYR 70%. Fiber content of blend sponge cake RYR samples varied between 0.13 to 0.26 %. Ash contents were significantly different ($p \leq 0.05$) amongst the blend sponge cake RYR samples except between RYR 50 and RYR 70 there no significantly different. The highest total carbohydrate content was 49.74% of sponge cake RYR 70. There were significant difference ($p \leq 0.05$) of ash and fiber amongst the blend sponge cake RYR samples.

Physical Characteristics of Sponge Cake Batters: The moisture contents of sponge cake RYR batters varied between 37.493 to 39.134%. The moisture contents of sponge cake RYR betters increased with increased red yeast rice flour level (Table 2). The moisture contents were significantly different ($p \leq 0.05$) amongst the betters of sponge cake RYR samples. All sponge cake batters were significantly different with increased red yeast rice flour level of the viscosity. The specific gravity of sponge cake batter is an indicator of the total air holding capacity but does not necessarily refers to the bubble size or dispersion information [34]. The specific gravity showed significant differences ($p \leq 0.05$) amongst RYR sponge cake batter with increased red yeast rice flour level. It might be due to dietary fiber content of red yeast rice flour that was higher than that of wheat flour [35]. Brys and Zabik [36] recorded an increase of cake batter specific gravity with increasing levels of microcrystalline cellulose.

Physical Characteristics of Sponge Baked Cakes: The weight and water activity of all baked sponge cakes had significantly ($p \leq 0.05$) with increased red yeast rice flour level except control, RYR 50 and RYR100 of water activity. The baked sponge cake volume had significantly ($p \leq 0.05$) with increased red yeast rice flour level except RYR 30 and RYR 70 of cake volume. Zhou *et al.* [34] mentioned that cake volume of baked cake is an indicate the amount of air entrapped through mixing and the air, CO_2 and moisture entrapped and expanded through baking. RYR30 and RYR70 recorded the highest sponge cake volume (80.0 cm^3/g) (Table 2). The high cake volume

Table 1: Proximate composition of red yeast rice sponge cakes

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	Carbohydrate (%)
Control	28.1±0.17[a]	6.99±2.15[a]	15.25±0.13[a]	0.39±0.01[a]	0.13±0.02[a]	49.14±2.48[a]
RYR 30	28.93±0.18[b]	6.75±1.98[b]	14.46±0.25[b]	0.50±0.01[b]	0.18±0.06[b]	49.18±2.32[b]
RYR 50	28.95±0.10[cb]	6.85±1.05[c]	13.55±0.34[c]	1.02±0.03[c]	0.20±0.05[c]	49.43±2.18[c]
RYR 70	29.14±0.09[d]	6.8±2.03[d]	13.07±0.18[d]	1.03±0.02[dc]	0.22±0.12[d]	49.74±2.52[d]
RYR 100	30.91±0.13[e]	5.94±1.12[e]	12.68±0.20[e]	0.87±0.01[e]	0.26±0. 15[e]	49.34±2.71[e]

RYR: red yeast rice

Each value is calculated as mean ± standard deviation. Means with different letters within a column differ significantly (P ≤ 0.05).

Table 2: Physical characteristics of red yeast rice batters and baked red yeast rice sponge cakes

	Red yeast rice sponge cake batters			Baked red yeast rice sponge cakes			
Samples	Moisture	Viscosity (cp)	Specific gravity at 30	Weight (gm)	Water activity	Volume (cm³/g)	Specific volume
Control	37.493±0.03	1000±47	1.087±0.01	39.64±0.91	0.780±0.004	83.00±0.17	2.09±0.02
RYR 30	39.413±0.04	1900±43	1.121±0.01	41.81±0.01	0.792±0.006	80.00±0.30	1.91±0.01
RYR 50	38.006±0.07	1800±65	1.105±0.02	37.79±0.06	0.818±0.005	74.00±0.04	1.96±0.01
RYR 70	39.134±0.02	1350±89	1.101±0.02	36.62±0.76	0.786±0.004	80.00±0.01	2.18±0.01
RYR100	37.959±0.01	2740±75	1.144±0.01	41.54±0.30	0.766±0.007	75.00±0.06	1.81±0.02

RYR: red yeast rice

Table 3: Hunter *L**, *a* b** and Ä E values of baked red yeast rice sponge cakes.

	Crust				Crumb			
Samples	*L**	*a**	*b**	Δ *E*	*L**	*a**	*b**	Δ *E*
Control	54.36±0.01	19.29±0.02	45.53±0.02	99.91±0.12	79.06±0.03	2.20±0.02	35.80±0.03	86.82±0.10
RYR 30	51.30±0.01	19.39±0.02	39.45±0.01	95.10±0.29	78.02±0.01	5.79±0.02	31.48±0.02	84.33±0.36
RYR 50	54.79±0.04	18.36±0.02	35.23±0.02	92.14±0.32	78.59±0.03	8.65±0.01	25.71±0.02	83.14±0.17
RYR 70	50.69±0.08	17.68±0.03	32.66±0.04	93.05±0.25	80.04±0.05	5.65±0.02	29.00±0.03	85.32±0.35
RYR 100	55.15±0.02	20.68±0.02	39.91±0.03	87.40±0.18	66.96±0.03	12.96±0.03	31.10±0.03	74.96±0.19

RYR: red yeast rice

Each value is expressed as mean ± standard deviation (n = 2).

L^* degree of lightness

a^* degree of redness

b^* degree of yellowness

ΔE total color difference

of baked cake does not always indicate a desirable cake, but lower cake volume of baked samples is an indicator of a heavy, less desirable crumb [37]. A good cake batter must retain sufficient viscosity to prevent the incorporated air bubbles from rising to the surface and being lost during initial heating [38-40]. The baked sponge cake specific volume had significantly (p ≤ 0.05) with increased red yeast rice flour level. The sponge cake RYR70 was recorded highest specific volume among RYR blended samples. Cakes containing RYR 30 and RYR 50 wheat fiber showed the highest specific volume 1.91±0.01 and 1.96±0.01 respectively [41].

Color Attributes of Baked Red Yeast Rice Sponge Cakes: Color attributes of sponge cake formulas are shown in (Table 3). The *L, a* and *b* values were corresponding to lightness, redness and yellowness, respectively. The crust color of sponge cake RYR blender was affected by the replacement of wheat flour with RYR30, RYR50, RYR70 and RYR100 flour (Table 3). In general, as RYR flour level increased, the crust of the control was lighter, redder and yellower than sponge cake RYR blender. For crumb color, as the level of RYR flour increased, the L and a values increased, indicating that a lighter and redder. The b values decreased, indicating less yellow crumb was obtained as a result of RYR flour substitution. It was observed that baked sponge cakes with RYR flour were lighter and redder than the control. Mau *et al.* [35] mentioned that the color change of baked cakes might be associated with black rice pigments and polyphenol compounds undergone oxidation reaction. The baked cakes became harder with increased levels of red yeast rice flour (Table 3). Overall color quality (ΔE) of crust and crumb sponge cake RYR were betters decreased with increased red yeast rice flour level.

Table 4: Texture profile analysis of baked red yeast rice sponge cakes.

Samples	Hardness (g)	Adhesiveness (mJ)	Springiness (mm)	Resilience
Control	1224±47	1.30±0.21	1.95±0.21	0.82±0.01
RYR 30	1298±63	0.40±0.12	1.43±018	0.85±0.01
RYR 50	1356±42	0.40±0.14	1.16±0.21	0.69±0.02
RYR 70	1485±46	1.20±0.22	1.41±0.25	0.59±0.02
RYR 100	1796±55	2.00±0.21	1.02±0.27	0.56±0.01

RYR: red yeast rice

Table 5: Total phenols and antioxidant property of baked red yeast rice sponge cakes

	Baked cake			
	Antioxidant property (µg TE/g)			
Samples	ABTS	DPPH	FRAP	TP (µg GAE/g)
Control	222.199±0.27	171.175±0.08	113.211±0.03	122.977±0.07
RYR 30	168.893±0.73	132.747±0.15	113.568±0.31	87.081±0.04
RYR 50	295.780±0.84	196.588±0.19	149.769±0.26	326.961±0.02
RYR70	243.223±0.68	178.710±0.17	175.044±0.20	259.192±0.05
RYR100	235.855±0.31	146.437±0.20	131.406±0.10	186.430±0.03

RYR: red yeast rice

ABTS= 2, 2-Azino-Bis, 3-Ethylbenzothiazoline-6-Sulphonic Acid

DPPH= stable 2, 2-diphenyl-1-picrylhdrazyel

FRAP= Ferric Reducing Antioxidant Potential

TP = Total phenols (µg Gallic Acid Equivalent)

Texture Profile Analysis of Baked Sponge Cakes: Texture profile analysis is important technique to investigate food products. In the current study the texture profile analysis of control sponge cake and blender sponge cake with RFR flour were determined in Table 4. The hardness values of sponge cakes increased significantly with increasing RYR flour level. There was significant difference ($p \leq 0.05$) of the hardness values among the RYR sponge cake blends. Springiness is defined as the distance to which the sample is recovered in height during the time that elapsed between the end of the first compression cycle and the start of the second compression cycle [42]. The springiness of control sponge cake and blender sponge cake with RFR flour exhibited significant difference ($p \leq 0.05$) among the blenders except RYR50 and RYR70. The adhesiveness showed the adherence ability of sponge cake to the probe at the stage after the first compression. Adhesiveness is defined as the negative force area between the first and second bites by the texture profile analysis software [35]. The texture profile analysis results recorded an increase in the RYR sponge cake adhesiveness with increased level of red yeast rice flour (Table 4). Resilience is expressed as the ratio of recoverable energy as the first compression is relieved. Texture profile analysis results indicated that the sponge cake springiness and resilience decreased with increased level of red yeast rice flour. Generally, as the percentage of RYR flour increased, the hardness, adhesiveness of baked sponge cakes increased. Whereas, the springiness and resilience of sponge baked cake samples decreased.

Total Phenols and Antioxidant Activity of Sponge Cake Extracts: Phenolic components of plants have been suggested to play a role as natural antioxidants [43]. The total phenols contents ranged from 87.081 to 326.961 µg GAE/g of RYR sponge cake. Total phenols content of baked sponge cake extracts significantly increased with increased RYR flour level that may be due to contents of total phenols of red yeast rice flour being higher than those of wheat flour. When the extraction yields and moisture content of baked sponge cakes were taken into consideration contents of total phenols of baked RYR cakes also significantly increased with increased red yeast rice flour level. The red rice is a good source of bioactive components, replacing wheat flour in the RYR cake blends with RYR flour would be an alternative and successful novel red yeast rice product. After baking, substantial amount of total phenols remaining in the red yeast rice sponge cake would be beneficial and provide consumers with the alleged physiological Properties. DPPH radical scavenging activity mostly used to assess the antioxidant potential that valued the antioxidant indices through free radical scavenging. Aniya *et al*. [44] studied DPPH radical

Table 6: Sensory quality characteristics of baked red yeast rice sponge cakes

Samples	Color	Taste	Odor	Texture	Appearance	Overall acceptability
Control	8.8±0.53[a]	8.1±1.43[a]	8.5±0.60[a]	8.8±0.42[a]	8.9±0.41[a]	8.60±0.58[a]
RYR 30	8.3±0.91[c]	7.9±0.82[c]	8.1±0.88[b]	7.9±0.85[c]	8.0±1.08[c]	8.04±0.65[c]
RYR 50	7.7±1.31[d]	7.5±1.13[d]	7.8±1.34[c]	7.6±1.17[d]	7.8±0.95[d]	7.80±0.89[d]
RYR70	8.0±0.66[b]	8.0±0.97[b]	8.1±0.62[b]	8.3±0.67[b]	8.4±0.62[b]	8.20±0.53[b]
RYR100	7.6±1.22[e]	7.4±1.22[e]	7.8±0.99[c]	8.6±0.76[e]	7.8±0.60[d]	7.60±0.77[e]

RYR: red yeast rice

Each value is expressed as mean ± standard deviation. Means with different letters within a column differ significantly ($P \leq 0.05$)

scavenging activity of 31 mold *Monascus* species and found that scavenged more than 60% of DPPH radicals for *M. anka, M. rubber* and *M. purpureus* The scavenging ability on DPPH radicals was assayed of RYR sponge cake blends in Table 4. The effectiveness in scavenging ability on DPPH radicals was decreased with increased red yeast rice flour level. The present study reported that supplemented RYR flour greatly enhanced antioxidant activity of the sponge cakes. These results suggest that total phenols have a strong effect on the antioxidant activity of the RYR sponge cake blends. Some synthetic antioxidants, such as butylated hydroxyl anisole (BHA) and butylated hydroxyl toluene (BHT), had good antioxidant properties, but they have carcinogenicity and toxicity at higher doses in rodents and monkeys, possibly resulting from pro-oxidative properties at higher concentrations. Besides, high concentrations of BHA and BHT can also increase spoilage of food items, rather than result in prolonged shelf-life due to pro-oxidant activities [45]. The BHA and BHT are food additives used or present in milligram levels in foods. However, red yeast rice is a natural food, could be consumed in gram levels as food and has higher acceptance by the consumers. Therefore, red yeast rice sponge cake could be developed as a novel functional food with more effective antioxidant activity. FRAP (ferric reducing antioxidant power) assay is based on reduction of ferric ion by phenol (Benzie and Strain, 1996). Results in Table 5 have illustrated that RYR70 has the maximum ferric reducing power 175.044 µg TE/g that was low 113.568 µg TE/g in RYR30. ABTS assay with 2, 2'-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) is based on free radical scavenging [23]. The maximum ABTS value was 295.780 µg TE/g recorded of RFR50 followed by 243.223 µg TE/g of RFR70 and lowest was 168.893 µg TE/g of RFR30.

Sensory Evaluation of Sponge Cake: There were scientifically differences ($p \leq 0.05$) among the RYR sponge cake blends formulas color, taste, odor, texture, appearance and overall acceptability of control, RYR30, RYR50, RYR70 and RYR100 (Table 6). The formula RYR70 sponge cake recorded the highest score were 8±0.66, 8±0.97, 8.1±0.62, 8.3±0.67, 8.4±0.62 and 8.2±0.53 of color, taste, odor, texture, appearance and overall acceptability, respectively. So the formula of RYR sponge cake were order in general to effect of RYR flour level add: formula RYR70 > formula RYR30 > formula RYR50 > formula RYR100. These sensory evaluation results refer to a partial substitution of wheat flour with up to 70 % red yeast rice flour in sponge cakes is acceptable.

CONCLUSIONS

Red yeast rice flour has several bioactive components, such as phenolic, antioxidant compounds and dietary fiber. Sponge cake formulated with partial substitution of wheat flour with up to 70% red yeast rice flour contained more bioactive components than the control cake. Besides, red yeast rice flour sponge cake showed good antioxidant activity. In general, to effect of RYR flour levels add of sensory evaluation: formula RYR70 > formula RYR30 > formula RYR50 > formula RYR100. Overall red yeast rice fermented by *Monascus ruber* AUMC 4066 could be incorporated into sponge cake and provides red yeast rice sponge cake with antioxidant properties as functional products.

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