Effect of Fat Substitution with Pre-gelatinized Riceberry Rice Flour on Physicochemical Properties, Sensory Acceptance and Shelf life of Salad Dressing

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Abstract. *The objectives of this research was to study substitution of soybean oil with pre-gelatinized riceberry rice flour of Buriram in low fat salad dressing product at 0, 10, 20, 30 and 40 percent of soybean oil weight. Study on physical and chemical properties, sensory evaluation and shelf life. It was found that substitution of pre-gelatinized riceberry rice flour increased with decreasing of lightness (L*) and yellowness (b*) of salad dressing, but the redness (a*) was increased ($p \le 0.05$). Total phenolic content, total anthocyanin content and antioxidant activity increased with increasing of pre-gelatinized riceberry rice flour ($p \le 0.05$). The pH value not significant different were between 3.89-4.01. Lipid content tend to decrease with increasing of pre-gelatinized riceberry rice flour ($p \le 0.05$). Sensory evaluated of fat substitute with pre-gelatinized riceberry rice flour of salad dressing was not significantly different ($p > 0.05$). The best formula was substitution soy bean oil with 30% pre-gelatinized riceberry rice flour. Study on the shelf life of salad dressing was packed in plastic jar and stored at 4 °C for 28 days. It was found that decreasing of color value, total phenolic content, total anthocyanin content and antioxidant activity with longer of storage periods. Lipid oxidation increased with increasing of storage periods ($p \le 0.05$). The result revealed that the total microorganism was not detected in salad dressing sample after storage at 4 ◦C for 28 days. Yeast and molds was found in the range of lower than 10 colonies ($p \le 0.05$), the salad dressing was shelf life at about 28 days.*

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1. Introduction

Food reduced in sugar, fat, or calories, along with sufficient exercise, can contribute to combating obesity and reducing the associated health risks. In addition, the consumer health love trend is growing up that healthy food products are attractive widespread. However, a large number of reduced-fat products face rejection because the consumers connect these products with poor organoleptic qualities [1]. New approaches are therefore required to provide high-quality (innovative of combinations) fat replacers, ideally based on vegetable proteins, dietary fibers, and hydrocolloids.

Pre-gelatinized starch is cooked and dried starch. It is also called alpha starch. It can be prepared by, for example, drum drying or spray drying. Pre-gelatinized starches, obtained by heating in the presence of water, are widely used for their technological properties, such as solubility in hot or cold water, high viscosity, and smooth texture. They can be used in food processing when thickening is required to improve texture, such as in cereal porridge, soups, creams, infant foods, salad dressings and in other non-thermally processed products [2,3]. Depending on the method, condition and source of starch, the produced pre-gelatinized starch has different properties.

Riceberry rice, having dark purple- colored grains, was a crossed-bred strain from Khao Hom Nin Rice variety and Khao Hom Mali 105 developed by Rice Research Center, Kasetsart University, Thailand. It contains many bioactive compounds such as gramma oryzanol, anthocyanins, flavonoid, niacin, thiamin, vitamin B2, beta-carotene, Zn, and total phenolic compounds. Besides, its purple pigment can be widely used as food colorants when processing bread, ice creams and liquor [4]. There is a growing interest in rice consumption due to the frequency of consuming nutrition that is associated with reducing risk of diseases, such as cancer, cardiovascular heart attack, diabetes, and high blood pressure [5].

A salad dressing is a non-newtonian, pseudoplastic fluid with viscoelastic properties and yield stress. The significance of the rheological properties of dressings has to do with their close relationship with quality, sensory attributes, shelf life, and microstructure [6]. Salad dressings are semisolid oil-in-water emulsions served with salad for flavor enhancement and modification. Salad dressing products can be classified into 2 main types: spoonable salad dressing (such as mayonnaise) and pourable salad dressing (such as creamy salad dressing or salad cream) [7]. Generally, the salad dressing contains vinegar, vegetable oil or salad oil, mayonnaise, mustard and sugar. The fat content in the formula is not less than 30% by weight and not more than 60%. The amount of egg yolks is not considered as solids less than 4% of the total egg yolk content used in the formula [8]. Therefore, the creamy salad has a sweet taste and is well liked by consumers. However, its high fat content can have negative health effects. If eaten frequently or in large quantities, such as coronary artery disease, obesity, high cholesterol, etc. Preparing a low-fat salad dressing by reducing the oil content of the salad dressing. As a result, the viscosity of the salad dressing is reduced and stratification can occur. In which there have been several studies that use thickening agents such as starch, hydrocolloids or other suspensions to improve texture, stability and stability.[9] For example, research found that the use of pre-gelatinized potato starch, 5% pre-gelatinized potato starch can improve stability in low-fat salad dressing [10]. The objective of this study, therefore, was to add pre-gelatinized riceberry starch subjected to different processing treatments to salad dressings and investigate the effect on physical properties, chemical properties, microbiological analysis, sensory acceptability as well as the shelf-life evaluation of the low fat salad dressings.

2. Material and Methods

2.1 Materials, Ingredient and Sample Preparation

Riceberry rice purchased from Buriram province Thailand. Riceberry rice was to cleaning, the ratio of 1 kg of riceberry rice per 5 liter of water and boiled at 100 ◦C for 45 minutes and dried at 60 °C until the moisture content access lower than 10% dry basis, then griding grains into powder with Grinder Model WF-10B. Riceberry rice flour was passed through 125 mesh sieve and further storage in vacuum packed in a laminated aluminum foil bag. Riceberry rice flour was storage at 4 ◦C until analysis.[11]

2.2 Preparation of Salad Dressing

Salad dressing formulations consisted of different ingredients are shown in Table 1 [12]. All the ingredients used were purchased from a local supermarket. For each preparation, one batch (100 g) of salad dressing was produced. The sample preparation was as follows: the egg yolk and vinegar were first mixed together; then all the other ingredients, except the soybean oil, were added and homogenized for 5 min in a mixer (Bear, DDQ−A40A1, China). Finally, the oil was added and additional homogenization for 2 min was done until homogeneous. The sample substitution of fat with pre-gelatinized riceberry rice flour, the following amounts of pre-gelatinized riceberry rice flour were added 10%, 20%, 30% and 40% (w/w). All formula were kept in a refrigerator 4 ± 2°C until their analysis. All samples were analyzed for physical properties, chemical properties, microbiological properties, and sensory evaluation within one day of production.

Formula	Soybean oil (g)	PGRRF (g)	Egg yolk (g)	Salt (g)	Vinegar (g)	Mustard (g)
Control	60	0	10	9	20	1
PGRRF-1	54	6	10	9	20	1
PGRRF-2	48	12	10	9	20	1
PGRRF-3	42	18	10	9	20	1
PGRRF-4	36	24	10	9	20	1

Note: PGRRF = Pre-gelatinized Riceberry rice flour, PGRRF-1 is 10% pre-gelatinized riceberry rice flour, PGRRF-2 is 20% pre-gelatinized riceberry rice flour, PGRRF-3 is 30% pre-gelatinized riceberry rice flour and PGRRF-4 is 40% pre-gelatinized riceberry rice flour

Table 1 Ingredients for salad dressing production

2.3 Color of Salad Dressing Evaluation

Color of all samples were evaluated using a colorimeter (Color Flex Hunter Lab Ez 45/0 L, USA) calibrated with a white calibration plate. The data were recorded as CIE L*, a* and b* parameters, where L* represents lightness (from 0 – black to 100 – white); a* and −a* for redness and greenness respectively; and b* and −b* for yellowness and blueness respectively. All samples were measured in triplicate.[13]

2.4 pH Evaluation

The pH value was to evaluated all sample by pH meter (Satorius AQ-PB 10) [14].

2.5 Lipid Analysis

Lipid was to analyzed by AOAC (2000) [15]. Sample were extracted by adding 25 ml of diethyl ether to the same flask and manually mixing for 5 min followed by the addition of 25 ml of petroleum ether with manual mixing for another 5 min. The mixture was allowed to stand for 1 hour to facilitate solvent layer separation. The organic phase (1:1 diethyl ether/petroleum ether mixture containing total lipids) was transferred to a pre-tared flask and dried under nitrogen to determine lipid dry weight. The lipid was calculated as follows equation (1).

$$\text{Lipid (\%)} = (A / B) \times 100 \quad (1)$$

Where A is weight of lipid and B is sample weight.

2.6 Total Phenolic Content

Total phenolic content was measured by the Folin–Ciocalteu assay along with spectrophotometer. Sample 2 g was extracted with 80% ethanol. The extraction mixture was shaken at 200 rpm for 2 hours at room temperature before centrifugation at 3500 rpm for 5 mins. The supernatants sample extract 0.5 ml was reacted with 10% Folin–Ciocalteu reagent 1.5 ml keep it in the dark 30 mins followed with addition of 7.5% $NaCO_3$ and incubation at room temperature for 15 min evaluation absorbance at 765 nm with the spectrophotometer. Gallic acid was applied as a standard, and the results were expressed as mg gallic acid equivalent (GAE)/100 g sample [16].

2.7 Total Anthocyanin Content

Total Anthocyanin content was analysis by pH-differential. A 0.2 ml of sample solution were dilute with KCl pH 1.0 and buffer solution CH_3COONa pH 4.5 after living room temperature in the dark for 20 min, the absorbance was measured at 520 and 700 nm using spectrophotometer. The total anthocyanin content was calculated as mg cyanin-3-glucoside equivalent per 100 g sample follows equation (2) [17].

$$\text{Monomeric anthocyanin (mg/liter)} = (A \times Mw \times DF \times)/(1000\varepsilon \times (1) \quad (2)$$

Where A is absorbance of sample, MW is Molecular weight as 499.2 $gmol^{-1}$ cyanidin-3-glucoside, DF is the Dilution factor, ε is the molar extinction coefficient; 26,900 $l.mol^{-1}.cm^{-1}$, cyanidin-3-glucoside.

2.8 Antioxidant activity

Antioxidant activity was analyzed by 2,2-diphenyl-2-picryhydrazyl method. A 0.2 mM DPPH solution 2 ml was prepared in ethanol and mixed with 3 ml sample solution. After living for 1 hr at room temperature in the dark, the absorbance was measured at 517 nm by using spectrophotometer. The inhibition percentage was calculated as follows equation (3) [18]

$$\% \text{ Inhibition} = [A_b - A_s)]/A_b \times 100 \quad (3)$$

where A_b is the absorbance of the DPPH blank control, A_s is the absorbance of the sample.

2.9 Sensory Evaluation of Salad Dressing

The sensory evaluation was carried out in a sensory laboratory. Sensory analysis based on a 9‒point hedonic scale of 1 to 9 (where scale 9 = Like Extremely, 8 = Like Very Much, 7 = Like Moderately, 6 = Like Slightly, 5 = Neither Like nor Dislike, 4 = Dislike Slightly, 3 = Dislike Moderately, 2 = Dislike Very Much, 1 = Dislike Extremely) was carried out. Sensory evaluation was performed by untrained panelists consisting of 40 untrained assessors. Sensory evaluation was conducted on the samples after one day cold storage at 4 ± 2°C. The samples were kept tempered at 4 ± 1°C before testing. The assessors were given representative salad dressing of 10 g placed in white plastic glass fitted with lids; all samples labeled with 3‒digit random numbers and presented randomized complete block design were randomly served to panelists. The presentation order was also randomized using the random number generator. Five salad dressing samples were served at the same time, furthermore drinking water was provided to rinse the palate between samples [19]. Salad dressing were evaluated in term of color, appearance, viscosity, texture, odor, flavor, taste and overall acceptability. The sensory evaluation was carried out in a testing area with properly controlled environmental conditions.

2.10 Shelf Life Evaluation

Experimental it was found that the fat substitute salad dressing formula with 30% pre-gelatinized riceberry rice flour was the best. Salad dressing were kept at 4 °C were analyzed shelf life for 28 days. Sample was analyzed physical, chemical and microbiological properties.

2.10.1 Physical and Chemical Properties

Fat substitute salad dressing formula with 30% pre-gelatinized riceberry rice flour (PGRRF-3) was analyzed physical and chemical properties were color, total phenolic, total anthocyanin and antioxidant activity according to method 2.3, 2.6, 2.7 and 2.8.

2.10.2 Lipid Oxidation Measurement by Thiobarbituric Acid-Reactive Substances (TBARS)

Salad dressing was to analyzed thiobarbituric acid reactive substances (TBARS) method. Sample 0.5 g was reacted with 2.5 ml of TBA solution consisting of thiobarbituric acid (0.375%), trichloroacetic acid (15%) and HCl (0.25 N). Samples were vortexed and incubated in a water bath at 90 °C for 15 min. Samples were cooled to room temperature and centrifuged at 2500 g for 15 min at 5 °C. The absorbance of the supernatant was read at 531 nm against a blank prepared with 1 ml of Double-deionized water (DDW) and 2 ml of TBA/TCA solution. The result were calculated using a standard curve prepared using 1,1,3,3-tetramethoxypropane expressed as milligrams of malondialdehyde (MDA) per kilogram of salad dressing [20].

2.10.3 Microbiological Analysis

For the microbiological assessments, 25 g of sample were added to 225 mL of sterile 0.1% peptone water (Himedia, India) and blended in a stomacher (Seward, 400 Circulator Lab Blender, UK) for 1 min. The samples were serially diluted and 1 ml of an appropriate dilution was used to inoculate a plate in duplicate. The viable populations of the principal groups of microorganisms were determined by plate inoculation and incubation at 37 ◦C up to 2 days (for total aerobic count) and at 28 ◦C up to 3 days (for yeast and mold) before counting the colonies in the following selective media: total aerobic bacteria in Plate Count Agar (Standard Methods Agar) (Himedia, India), yeasts and moulds in Potato Dextrose Agar (Himedia, India) [21]. Duplicate nutrient agar plates of that dilution were selected that contained 30-300 colonies per plate. Colonies on both of the plates were counted and average of the two counts was taken to calculate colony counts. All of the results were expressed in Colony Forming Unit (log CFU/g). Reported data are the means of triplicate analyses.

2.11 Statistical Analysis

All analyses were conducted in triplicate and were reported as means ± standard deviation. The statistical significance of difference was evaluated by one-way analysis of variance (ANOVA) using the SPSS statistical software program version 20. The physical properties, chemical properties and shelf life of samples were analyzed by analysis of variance (ANOVA) using Completely Randomized Design. The results from sensory evaluation were analyzed by analysis of variance using Randomized Complete Block Design. The experimental data were subjected to an ANOVA and the Duncan's multiple range test (DMRT) (P≤0.05) was used to identify significant differences between group means.

3. Results and Discussion

3.1 Color Value

Fig. 1 shows the color value of salad dressing control formula and substitution of soybean oil with pre-gelatinized riceberry rice flour. The graph also shows the reduction of lightness (L*), yellowness (b*) with increasing of pre-gelatinized riceberry rice flour (p≤0.05). The redness (a*) tended to increase with increasing of the pre-gelatinized riceberry rice flour shown at Fig. 1 (p≤0.05). Reduction of lightness (L*) and yellowness (b*) with increased of pre-gelatinized riceberry rice flour, but redness (a*) tends to increase because of the anthocyanin pigment with purplish red color causes the salad dressing to shift more towards blue [22]. Riceberry rice has anthocyanin was found reddish purple pigment. Similar with result of Leelawat and Kaewsaad [23] reported that L* and b* decrease but the a* increased with increasing of supplemented with purple rice flour at low-fat salad dressing.

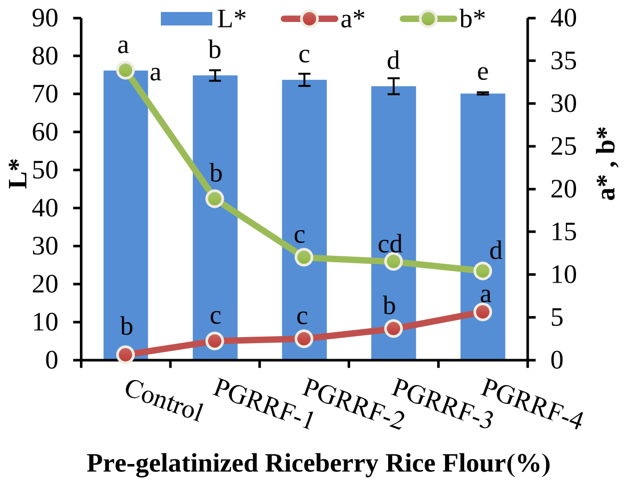

Fig. 1 Color value of fat substitution salad dressings with pre-gelatinized riceberry rice flour at different levels

The salad dressing formula substitute 40% pre-gelatinized riceberry rice flour had the highest a* value and the control formula had the highest b* value. The color difference values differed from the control formula, highest color difference was found that substitute 40% pre-gelatinized riceberry flour because of different from control formula.

3.2 Bioactive Compounds

Analysis of total phenolic content was measured by the Folin–Ciocalteu assay. As Table 2 shown replacing soybean oil with pre-gelatinized riceberry rice flour in salad dressing, it was found that total phenolic content tends to increase with increasing of pre-gelatinized riceberry rice flour (p≤0.05). Total anthocyanin was analyzed by pH differential [24]. The experimental showed that total anthocyanin content tend to increase with increasing of pre-gelatinized riceberry rice flour show in Table 2 (p≤0.05).

Formula	Total Phenolic content (mg GAE/100 g)	Total Anthocyanin (mg/100 g)	% Inhibition
Control	111.61^{e}±0.43	-	16.33^{c}±1.16
PGRRF-1	145.71^{d}±4.61	109.62^{d} ±0.04	18.29^{b}±0.16
PGRRF-2	164.97^{c}±7.39	185.95^{c} ±0.07	19.27^{ab}±0.12
PGRRF-3	186.46^{b}±2.32	301.24^{b}±0.11	19.87^{ab}±0.57
PGRRF-4	225.01^{a}±1.93	362.45^{a} ±0.08	21.15^{a}±0.36

Note: Mean value with different letters in each column are significantly different (p≤0.05); ns = non significantly different (p>0.05).

Table 2 Bioactive compounds of fat substitution salad dressings with pre-gelatinized riceberry rice flour at different levels.

Antioxidant activity of products increased along with increasing of pre-gelatinized riceberry rice flour in the product, 16.33%, 18.29%, 19.27%, 19.87% and 21.15 %, respectively (Table 2). As expected, formula 40% pre-gelatinized riceberry rice flour (PFRRF-4) highest of bioactive compounds (p≤0.05). Total phenolic content, total anthocyanin and antioxidant activity increased with increasing of pre-gelatinized riceberry rice flour because of pre-gelatinized riceberry rice flour contains bioactive compounds such as phenolic compounds, anthocyanin, vitamin E complex (tocopherols and tocotrienols), phytosterols, phytic acid, phenols, γ-oryzanols, tricin and antioxidant activity [25,26]. Therefore, the increased substitution of pre-gelatinized riceberry rice flour resulted in a high in bioactive compounds. The same as experimental results of Tantivirasut *et al.* [27] reported that total anthocyanin, total phenolic content and antioxidant activity of salad dressing inclined to increase with increasing of ratio pregelatinized riceberry flour.

3.3 Lipid and pH Value

Analysis of pH values of salad dressing replacing soybean oil with pre-gelatinized riceberry flour at different levels. It was found that pH were between 3.89-4.01 tended to increase when the amount of pre-gelatinized riceberry flour increased (p>0.05). However, the pH value is less than 4.1, according to the standard of salad dressing, the pH must be less than or equal to 4.1. (Table 3)

Lipid was measurement, the result represented that the fat tends to decrease with increasing of pre-gelatinized riceberry rice flour (p≤0.05). Similar result of decreased of fat content in the creamy salad dressing with concentration of oatmeal increased (p≤0.05) [7], and incorporating gac aril in salad dressing found that reduced fat content [19, 28]. It could be assumed that replacing soybean oil with pre-gelatinized riceberry rice flour can reduced fat content.

Formula	pH^{ns}	Lipid (%)
Control	3.89±0.02	54.14^{a}±1.35
PGRRF-1	3.92±0.03	45.15^{b}±2.56
PGRRF-2	3.94±0.01	38.25^{c}±1.22
PGRRF-3	3.92±0.03	31.19^{d}±2.56
PGRRF-4	4.01±0.02	26.22^{e}±1.38

Note: Mean value with different letters in each column are significantly different (p≤0.05); ns = non significantly different (p>0.05).

Table 3 Lipid and pH of fat substitution salad dressings with pre-gelatinized riceberry rice flour at different levels

3.4 Sensory Evaluation

Sensory assessment was performed using a 9-point hedonic scale, assessing sensory characteristics in terms of color, smell, taste, viscosity and overall preference. It was found that the color, odor and taste preference scores of all formulas were not significantly different (p>0.05). For the 30% pre-gelatinized riceberry rice flour substitute formula, the viscosity score and overall liking scores were higher than the other formula, having scores at 7.30±0.92 and 7.57±0.82, respectively. The best formula was the soybean oil substitution with 30% pre-gelatinized riceberry rice flour was analyzed the physical and chemical properties were most similar to the products on the market. The chemical properties were analyzed total anthocyanin content, total phenolic content and the antioxidant activity was high this will be used to study the shelf life. Shelf life were analysis of physical, chemical properties and shelf life.

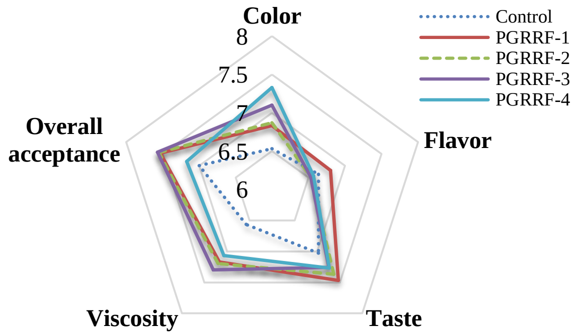

Fig. 2 Sensory evaluation of fat substitution salad dressing with pre-gelatinized riceberry rice flour at different levels

3.5 Shelf Life of Salad Dressing

3.5.1 Color Value

Color values of salad dressing were analyzed during storage at 4 °C. The experimental found that the L*, a* and b* trended to decrease with increasing of storage time [15]. Color changes during storage due to salad dressing occur oxidation of lipid reaction with light, oxygen and moisture.

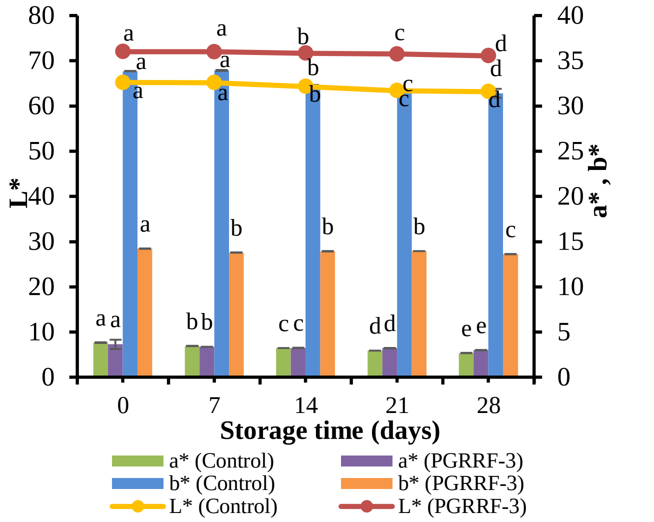

Fig. 3 Color value of PGRRF-3 during storage at 4 °C for 28 days

The result similar with Leelawat and Kaewsaad [23] found that L*, a* and b* of salad dressing decreased with increasing of storage time. The less redness color of the salad dressing could be due to anthocyanin a pigment found in riceberry rice flour, which gives it its red color in acidic environments, with increased retention time because of anthocyanin were unstable pigment. The degradation can be caused by many factors, including pH, temperature, light and oxygen [29].

3.5.2 Bioactive Compounds Changes during Storage

Analysis chemical properties of low-fat salad dressing products packed in plastic jars and stored at 4 °C for 28 days. Total anthocyanins of controlled dressings and the 30% pre-gelatinized riceberry rice flour substitute formula tended to decrease with longer storage periods.

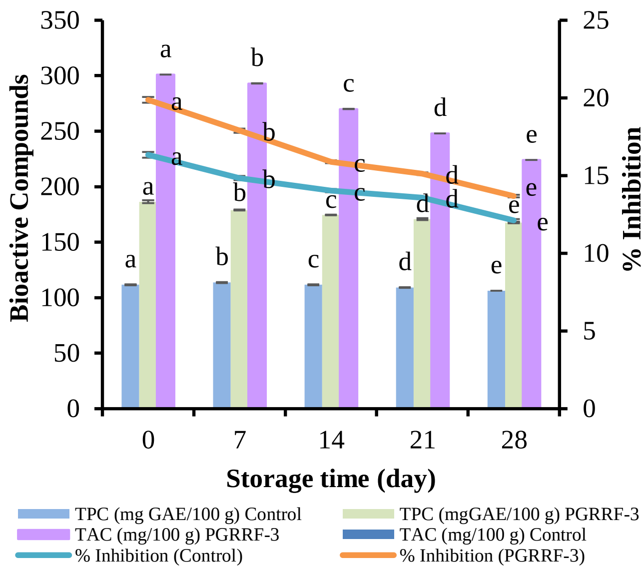

Fig. 4 Bioactive compounds of control and PGRRF-3 during storage at 4 °C for 28 days.

This may be due to all phenolic compounds and anthocyanins are susceptible to decay due to structural instability due to light, oxygen. [30] This corresponds to the decrease in antioxidant activity as the storage time was increased ($p \leq 0.05$) (Fig. 4.). Consistent with the research of Naknaen *et al.* [19], it was found that the total anthocyanin content and all phenolic compounds and the antioxidant activity decreased with increasing shelf life ($p<0.05$).

3.5.3 Changes in TBARS during Storage

The TBARS measurement is a common method to monitor the secondary products of lipid oxidation, mainly malonaldehyde. As shown in Fig.5, thiobarbituric acid reactive substances (TBARS) trend to increase in all the samples during the 28 days of storage time ($p<0.05$). Salad dressing with substitution of pre-gelatinized riceberry rice flour contained a lower TBARS than control sample, maybe because of the phenolic compounds, anthocyanin in pre-gelatinized riceberry rice flour to prevent lipid oxidation in the salad dressing. A trend to increase in TBARS was found that both control sample and sample containing PGRRF during 28 days of storage.

Lipid oxidation is one of the major concerns in food quality deterioration. The oxidative may be catalyzed by oxygen, light, heat, enzyme, metal and microorganism that lead the development off-flavor [31]. The result obtained from the TBARS confirmed that phenolic compounds, total anthocyanin effectively worked as antioxidant compounds more active oxidizing forms, such as malonaldehyde, in salad dressing in the presence of light.

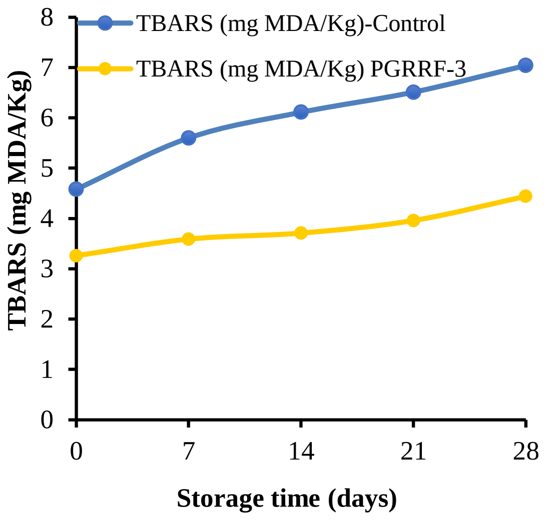

Fig. 5 TBARS of control and PGRRF-3 during storage at 4 °C for storage 28 days

3.5.4 Microbiological Changes during Storage

Analysis of microorganisms, yeast and mold, it was found that growth of all microorganisms was not found. For yeast and molds less than 10 CFU/g at storage 28 days, conforming to the Community Product Standard. Low fat salad dressing products defined as having all microbial count of 10^4 CFU/g and the number of yeast & molds does not exceed 10^2 CFU/g. The absence of all microorganisms may be due to storage conditions at 4 °C for 28 days, the condition that can slow the deterioration of the food. The result revealed that the all microorganism was not detected in salad dressing sample after storage at 4 ◦C for 28 days.

Yeast and molds was found in the range of lower than 10 colonies. Probably, the pH conditions of the salad dressing products prevented the growth of spoilage microorganism, acting as a antimicrobial agent [21]. The mold growth is limited because of limited oxygen in the packaged material shown at Table 4 [32].

Storage time (day)	**All microorganism (CFU/g)**		**Yeast & Mold) (CFU/g)**	
	control	**PGRRF-3**	**control**	**PGRRF-3**
0	ND	ND	ND	ND
7	ND	ND	ND	ND
14	ND	ND	ND	ND
21	ND	ND	ND	ND
28	ND.	ND	<10	<10

Note: ND = not detect

Table 4 Microbiological properties of control and PGRRF-3 during storage at 4 °C for 28 days

4. Conclusion

This study demonstrated that substitution of soybean oil with pre-gelatinized riceberry rice flour could be alternative of reduces fat content of salad dressing. The values of their color parameters depended on the ratio of pre-gelatinized riceberry rice flour. Salad dressing formula PGRRF-3 substitution of soybean oil with 30% pre-gelatinized riceberry rice flour, the experimental results of physical properties, chemical properties and consumer acceptance, the highest accepted product. Salad dressing product substituted for 30% pre-gelatinized riceberry rice flour was measurement shelf life for 28 days at 4 ◦C, it was found that the storage time affected the color value, total phenolic content, total anthocyanin content and the antioxidant activity tended to decrease as the storage period increased. Therefore, low fat salad dressing produced could be considered as one of the healthy foods which contribute benefits to consumers. Further research should be carried out regarding on proximate analysis and longer periods storage should be to make a commercial product.

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References

[1] C. N. Schädle, S. Barder-Mittermaier, S. Sanahuja, "Characterization of reduce-fat mayonnaise and comparison of sensory perception, reological, tribological, and texture analyses," *Foods*, 2022, pp. 1-20.

[2] H. T. Tô, S. J. Karrila, L. H. Nga and T. T. Karrila, "Effect of blending and pregelatinizing order on properties of pregelatinized starch from rice and cassava," *Food Research*, 2020, pp. 102-112.

[3] X. Ding, L. Wang, T. Li, F. wang, Z. Quan, M. Zhou, Z. Huo, "Pre-Gelatinisation of rice flour and Its effect on the properties of gluten free rice bread and its batter," *Foods*, 2648.

[4] C. Thongkaew and J. Singthong, "Effect of partial substitution of riceberry rice flour on rice noodles quality," *Food Research*, 2020, pp. 9-16.

[5] N. Settapramote, T. Laokuldilok, D. Boonyawan and N. Utama-ang, "Physiochemical, Antioxidant Activities and Anthocyanin of Riceberry Rice from Different Locations in Thailand," *Food and Applied Bioscience Journal*, 2018, pp. 84-94.

[6] Z. Ma, J.I. Boye, J. Fortin, B. K. Simpson and S. O. Prasher, "Rheological, physical stability, microstructural and sensory properties of salad dressings supplemented with raw and thermally treated lentil flours," *Journal of Food Engineering*, 2013, pp. 862-872.

[7] N. Sumonsiri, B. Panjun, S. Naksuk, S. Boonmawat, A. Mukprasirt and P. Phasuthan, "Effect of Oatmeal as a Fat Replacer on Physical Properties and Sensory Acceptance of Creamy Salad Dressing." *E3S Web of Conferences*, 2020, pp. 1-5.

[8] S. Featherstone, "Mayonnaise and Salad Dressing Products, a Complete Course in Canning and Related Processes" *In Woodhead Publishing Series in Food Science, Technology and Nutrition, 14th Ed.*, Woodhead Publishing, Sawston, 2016, pp. 369-384.

[9] I. M. Hayati, Y. B. C., Man, C. P., Tan and I. N., Aini. "Droplet characterization and stability of soybean oil/palm kernel olein o/w emulsions with the presence of selected polysaccharides" *Food Hydrocoll*, 2009, vol. 23, pp. 233-243.

[10] G. Bortnowska, J. Balejko, V. Schube, G. Tokarczyk, N. Krzemińska and K. Mojka, "Stability and physicochemical properties of model salad dressings prepared with pregelatinized potato starch," *Carbohydrate. Polymer*. 2014, vol. 111, pp. 624-632.

[11] S. Hedayati, F. Shahidi, A. Koocheki, A. Farahnaky, and M. Majzoobi, "Influence of pregelatinized and granular cold water swelling maize starches on stability and physicochemical properties of low fat oil-in-water emulsions," *Food Hydrocolloids*, 2020, vol. 102, pp. 1-6.

[12] N. Sarabood, "Physicochemical and rheological of low-fat salad dressings from a mixture of waxy flour, rice flour and cornstarch," (Thesis) *Master degree of Food Science and Technology*, 2009, *Mahasarakham University, Thailand*, Retrieved http://tdc.thailis.or.th/tdc/search_result

[13] H. Afshari-Jouybari, and A. Farahnaky, "Evaluation of photoshop software potential for food colorimetry," *Journal of Food*, 2011, vol. 106, no. 2, pp. 170-175.

[14] M. Majzoobi, Z. Kaveh and A. Farahnaky, "Effect of acetic acid on physical properties of pregelatinized wheat and corn starch gels," *Food Chemistry*, 2016, pp. 720-725.

[15] AOAC, official Methods of Analysis (International, 19th ed. Williams, S), *Association of official Analytical Chemists, Arilington, Virginia*, 2012.

[16] Q. Deng, M.H. Penner and Y. Zhao, "Chemical composition of dietary fibre and polyphenols of five different varieties of wine grape pomace skins," *Food Research International*, 2011, vol. 44, no. 9, pp.2712-2720.

[17] J. Lee, R. W. Drust, and R.E. Wrolstad, "Determination of total monomeric anthocyanin pigment content of fruit juices, beverages, Natural colorants and wines by pH differential method: collaborative study," *Journal of AOAC International*, 2005, vol. 88, pp.1269-1278.

[18] A. Tseng and Y. Zhao, "Wine grape pomace as antioxidant dietary fibre for enhancing nutritional value and improving storability of yogurt and salad dressing," *Food Chemistry*, 2013, vol. 138, pp. 356-365.

[19] P. Naknaen, N. Chinnapitiwong, and P. Kruayoo, "Enhancing the quality attributes of salad dressing by incorporating Gac aril as a biologically active ingredient," *Brazilian Journal of Food Technology*, 2018, vol. 21, e2017129.

[20] S. Maqsood and S. Benjakul, "Comparative studies of four different phenolic compounds on in vitro antioxidative activity and the preventive effect on lipid oxidation of fish oil emulsion and fish mince," *Food Chemistry*, 2010, pp. 123-132.

[21] A. D. Bruno, R. Romeo, A. Gattuso, A. Piscopo and M. Poiana, "Functionalization of a Vegan Mayonnasise with High Value Ingredient Derived from the Agro-Industrial Sector," *Foods*, 2021, 2684.

[22] E.S.M. Abdel-Aal, J.C. Young and I. Rabalski, "Anthocyanin composition in black, blue, pink, purple and red cereal grains," *Journal of Agricultural and Food Chemistry*, 2006, vol. 54, pp 4696-4704.

[23] B. Leelawat and T. Kaewsaad. "Development of Low-Fat Salad Dressing Supplemented with Purple Rice Flour" *Thai Science and Technology Journal*, 2018, vol. 5, pp. 774-789.

[24] A. N. Kim, H. J. Kim, J. Chun, H. J. Heo, W. L. Kerr and S. G. Choi, "Degradation kinetics of phenolic content and antioxidant activity of hardy kiwifruit (Actinidia arguta) puree at different storage temperatures," *Food Science and Technology*, 2018, vol. 89, pp. 535-541.

[25] V. Leardkamolkarn, W. Thongthep, P. Suttiarporn, R. Kongkachuicchai, S. Wongpornchai and A. Wanavijitr, "Chemopreventive properties of the bran extracted from a newly-developed Thai rice," *Food Chemistry*, 2011, vol. 25, pp. 978-985.

[26] P. Arjinajarn, N. Chueakula, A. Pongchaidecha, K. Jaikumkao, V. Chatsudthipong,S. Mahatheeranont and A.Lungkaphin, "Anthocyanin-rich riceberry bran extract attenuates gentamicin-induced heptotoxixicity by reducing oxidative stress, inflammation and apoptosis in rats," *Biomedicine & Phamacotherapy*, 2017, pp. 412-420.

[27] P. Tantivirasut, N. Laohakunjit, U. Suttisansanee, C. Hudthagosol and P. Somboonpanyakul. "Effect of Pregelatinized Riceberry Flour for Reducing Fat in Salad Dressing", *Journal Agricultural Science*, 2014, vol. 45, no. 2, pp. 125-128.

[28] N. Sumonsiri, B. Panjun, S. Naksuk, S. Boonmawat, A. Mukprasirt and P. Phasuthan, "Effect of Oatmeal as a Fat Replacer on Physical Properties and Sensory Acceptance of Creamy Salad Dressing," 2020, *E35 Web of Conferences*, vol. 141, 02006.

[29] B. Leelawat and T. Kaewsaad, "Development of Low-Fat Salad Dressing Supplemented with Purple Rice Flour," *Thai Science and Technology Journal*, 2018, vol.5, pp. 774-789.

[30] O. R. Fennema, "Food Chemistry," 3rd Ed, *Marcel Dekker, Inc*, *New York*, 1966.

[31] I. Sànchez-Alonso, A. Jimènz-Escrig, F.saura-Calixto and A. J. Borderìas, "Effect of grape antioxidant dietary fibre on prevention of lipid oxidation in minced fish: Evaluation by different methodologies," *Food Chemistry*, 2007, vol. 101, pp. 372-378.

[32] R. Tavakoli, M. Karami, S. Bahramian and A. Emamifar, "Production of Low-fat mayonnaise without preservatives: Using the ultrasonic process and investigating of microbial and physicochemical properties of the resultant product," *Food Science and Nutrition*, 2021, pp. 1-10.

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