International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG(USA) Volume 5, Issue 5 - 2018

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2018.05.05.016

Physical and sensory quality of Roselle seed flour cookies

Karma Bako Rimamcwe, U. D. Chavan*, S. B. Lande, C. A. Nimbalkar and U. S. Dalvi

Department of Food Science and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri
*Corresponding author: *uttamchavan08@gmail.com*

Abstract

The physical evaluation of cookie in sensory test, colourimetry and texture analysis adjudged at various levels and 15% inclusion was the best treatment for Roselle seed flour for cookie production. The result for cookie nutritional values shows an improvement in proximate composition as well as physical properties and sensory parameters. The summary of the total colour difference (ΔE*) for selected cookies in sensory evaluation showed SDRSF at 15-85% ratio having the highest colour difference with ΔE* value 5.12 followed by UDRSF 3.87 and RSO15-35% ratio 1.26. The overall summary of texture profile showed that the crushing force (N) for SDRSF 15-85% ranked highest when compared to control, followed by UDRSF 15-85% and RSO 15-35%.

Keywords: Roselle seed flour, Cookies, Nutritional value.

Introduction

Roselle (*Hibiscus sabdariffa* Linn.) is a tropical plant belonging to the Family *Malvaceae* and widely cultivated for its jute like fiber in India, the East Indies, Nigeria and to some extent in tropical America (Yayock, 1988). A woody sub-shrub growing 7-8 feet (2-2.5m) tall, acting as annual or perennial, takes about six months to mature. The mature plants are highly drought resistant but may require water during dry periods when soil moisture is depleted to the point where wilting occurs. Roselle requires a chalky, loamy and peat-rich soil with pH of 7.6-9.0; and grows best in weakly alkaline soil (Myfolia, 2016; Karma and Chavan, 2016; Karma and Chavan, 2017 and Karma *et al*., 2017a, b, c).

The lipid profile indicated Roselle seed oils are good sources of phospholipids, the levels of which compare favorably with that of Soybean oil (1.5 to 2.5%; Gunstone, 2002). This high level of phospholipids may contribute to the stability and antioxidant activity of the oils. Antioxidant compounds are gaining importance due to their dual role in food and pharmaceutical industries as lipid stabilizers (Ramadan and Morsel, 2004). Nutritionally important antioxidants such as tocopherols improve the stability of oil. In a study, Roselle seed oil (RSO) and Roselle seed extract (RSE) was mixed with Sunflower oil, respectively to monitor degradation rate and investigate antioxidant activity during accelerated storage. The antioxidant activity was found to stabilize Sunflower oil of various samples and in the order of RSE > RSO > Tocopherol > Sunflower oil (Nyam *et al*., 2012).

The proximate composition of whole Roselle seeds indicated that, seeds contained relatively high fat and protein (20.97% and 29.61% respectively). The physico-chemical parameters of crude oil extracted from Roselle seeds by soaking at room temperature (cold extraction) indicated the oils had 1.4674 refractive index; 0.078 (at 420nm) yellow-greenish colour, 0.78% acidity, 198.82 saponification value, 97.62 (g of I_2/100g oil) iodine value; 1.52% unsaponifiable matter; 4.82 (Meq 0_2/Kg oil) peroxide value; 6.21p-anisidine value; and 15.85 totox number. Gas Liquid Chromatography technique has been developed for identification and quantitative determination of total unsaturated and saturated fatty acids. This technology showed that Roselle crude oil had 73.40% unsaturated and 26.57% saturated fatty acids respectively. Major fatty acid found was oleic acid (38.46%) followed by linoleic (33.25%) and Stearic (5.79%). Stability of crude Roselle seed oil against oxidation during the accelerated storage of oil indicated that the crude oil induction period to be 10 days at 65^0C. The relatively high fat content of the seeds and high protein content of resulted meal beside the relatively high oxidation stability of Roselle suggest that Roselle seeds could be a novel and economic source of healthy edible fat and for other food industry applications.

Roselle plants are mostly used in the processing industry for extraction of fiber. Roselle seed is the byproducts of the Roselle processing industry (Bamgboye and Adejumo, 2009). This unwanted byproduct can be recycled as value added food supplements, as it provides advantageous bio-active compounds, good source of edible oil and proteins (Bertagnolli *et al*., 2014; Nyam *et al*., 2012). Roselle seeds can be ground into fine flour and used for enriching other cereals such as wheat in value added products.

The wheat (*Triticum spp.*) is grown on more land area than any other commercial crop (USDA, 2016). World trade in wheat is greater than all other crops combined (Curtis *et al*., 2002). Blending Roselle seed flour with wheat flour in value added products will greatly popularize Roselle seeds, curbing it wastages especially in the tropics and also exposing its rich nutritional potentials for the overall health benefits to mankind. Protein fractions, proteins isolates or concentrates obtained from Roselle seeds might be an alternative source of low cost protein substitute in dietary supplement in ingredients for food industry. This may reduce the heavy dependence on conventional sources such as animal, fish and soybean proteins.

At present, there are very few reports on harnessing the bio-nutritional potential of Roselle seeds in value added products (Nyam *et al.,* 2014). Adding cereals with complementary nutritive profiles, such as Roselle seeds, may yield a more complete enrich food source (Okafor *et al*., 2002; Arshad *et al*., 2007; Bala *et al*., 2015; Wani *et al*., 2015). Combining the nutritional value of wheat and Roselle seeds in composite formulations may yield good quality food products with excellent nutritive qualities. Hence, the aim of this study was to investigate the bio-nutritional viability of Roselle seeds for the benefit of human race with production of Roselle seed flour cookies.

Materials and Methods

Raw Materials Collection.

Roselle (*Hibiscus sabdariffa* Linn.) and Wheat (*Triticum aestivum spp.*) seeds were both sourced from vegetable markets in Ahmednagar, Maharashtra State, India and both were of local varieties. The various ingredients: Margarine, granulated sugar, salt, sodium bi carbonate and ammonium bicarbonate used for baking were all provided from the pilot bakery unit of the Department of Food Science and Technology, Mahatma Phule Agricultural University, Rahuri

Germination: The cleaned seeds were soaked for 6 hours to activate the process of germination, after which the seeds were washed and allowed to drain. The drained seeds were then spread on a damped cloth in a perforated container with water sprinkled occasionally in a dark room to activate germination for a another 12 hour period; then gently washed and spread sparsely to dry under fan at ambient temperature to preserve its nutritive value, packed in a HDPE bag and stored in a cool dry place until used.

Preliminary Studies

To ascertain the best treatment of Roselle seeds to be selected for composite Roselle-Wheat flour formulation in cookie production for an enhanced nutrition and functional properties of the value added product, the following preliminary studies on pre-treatments where adopted for Roselle seeds.

1. Un-sprouted Whole Roselle Seeds Flour (UWRSF), as *Control*
2. Un-sprouted Decorticated Roselle Seed flour (UDRSF)
3. Sprouted Whole Roselle Seed Flour (SWRSF)
4. Sprouted Decorticated Roselle Seed Flour (SDRSF)

The pre-treatments were prepared accordingly: both cleaned raw and germinated (sprouted) seeds were divided into two portion each, the first portion was grind whole with a laboratory scale hammer mill and the resulting powder sieved through a 60 mesh screen filter until a fine whole seed powder was obtained; the second portion was coarse grind with sieving intermittently to separate out the bran to obtain a decorticated flour then further grind to a fine mix. The resulting whole and decorticated cleaned (raw and sprouted) seed flour fractions obtained were packed separately in a HDPE bag and stored in a cool dry place until used.

Cookie Preparation

The *molded cookie* was adopted for this study owing to its simplicity Wikipedia (2016). The Cookie was prepared according to proposed method by Noor Aziah *et al.* (2012) with modification; using basic ingredients (Wani *et al.*, 2015) to simplify critical investigations.

Ingredients formulation

Ingredients and composition for composite flour for cookies (g).

Ingredients (at 100 g basis)	Control	Flour Replacement			
		10%	15%	20%	25%
Flour	100	10:90	15:85	20:80	25:75
Sugar	40	40	40	40	40
Margarine	50	50	50	50	50
Sodium bicarbonate	0.5	0.5	0.5	0.5	0.5
Ammonium bicarbonate	0.5	0.5	0.5	0.5	0.5
Water	20	20	20	20	20
Salt	1	1	1	1	1

Physicochemical evaluation of cookie

Weight, Diameter and Thickness: Ten pieces of cookies were randomly selected for 10 replications. The three most important dimensions *viz.* length, width and thickness were measured with a digital micrometer Vernier Caliper manufactured by Mitutoyo Corporation, Japan to an accuracy of 0.001mm.

Spread ratio (D/T) and Spread factor (SF) were determined using equation described (Hussain *et al.* 2006; Nyam *et al.*, 2014)

$$SF = \frac{D}{T} \times CF \times 10$$

Where: CF is the correction factor at constant atmospheric pressure taken as 1.0 in this study.

Sensory evaluation

Sensory evaluation of sample cookies was done using Hedonic test on a 9 scale points based on appearance, flavor, crispiness, taste and overall acceptability from 20 semi trained panelists (Amerine *et al*., 1980).

Colour determination

Colour difference of sample cookies compared to the standard sample was measured by a colour scanning machine (Premier Colourscan, Thane). The principle described by Konica (2016) was employed for this determination. The Commission Internationale de I'Eclairage (CIE), L*a*b* coordinates was adopted for this study. It provides reading in terms of L^*, a^* and b^*. Where, luminance (L^*) forms the vertical axis, which indicates lightness (+) to darkness (-). In the same way a^* indicates redness (+) to greenness (-) and b^* indicates yellowness (+) to blueness (-).

The instrument was standardized before placing the sample by placing the standard cookie sample in the instrument. Once the instrument was standardised, it was ready to measure the colour. The sample was filled in the sample cup. The deviation (ΔE^*) of the colour of the sample to standard was observed and recorded in the computer interface expressed using the equation:

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta a^*)^2}$$

Colorimetry is the technique used to identify colour difference between samples and how they differ from standard. No matter how close two samples look the same, slight difference may be found when evaluated with a colour measurement instrument. The colour differences between cookie samples were studied using the CIE L* a* b* coordinates a rectangular coordinate system defined by Commission Internationale de I' Eclairage (CIE), the L* a* b* colour space was modeled after a colour-opponent theory stating that two colours cannot be red and green at the same time. Where L* indicates lightness, a* is the red/green coordinates, and b* is the yellow/blue coordinate. Deltas for L* (ΔL*), a* (Δa*) and b* (Δb*) may be positive (+) or negative (-). The total difference, Delta E (ΔE*) is however always positive.

Where:

ΔL* (L* sample minus L* standard) = difference in lightness and darkness (+ = lighter, - = darker).
Δa* (a* sample minus a* standard) = difference in red and green (+ = redder, - = greener).
Δb* (b* sample minus b* standard) = difference in yellow and blue (+ = yellower, - = bluer). And,
ΔE* = Total Colour Difference.

Texture analysis of cookies

Texture analysis of cookies was performed for cutting force, crushing force and penetration force using Universal Testing Machine (Shimadzu, Japan, Model No. AG-X, with 2500N Capacity) Texturometer in the instrumentation laboratory of Dr. Annasaheb Shinde college of Agricultural Engineering and Technology, Department of Agricultural Process Engineering MPKV, Rahuri. Each cookie was placed on the loading cell and compressed. The conditions employed were as follows; cross head speed: 50mm/min, maximum load cell force: 1 kg and compression: 75 per cent. The maximum force required to just break the cookies is the hardness. It was expressed in terms of Newton (N).

Statistical analysis

All experiments were carried out in such a way that the degree of freedom remains more than 12 with suitable replications and treatments. Data obtained in the present study were analyzed by Completely Randomized Design (CRD) design as given by Panse and Sukhatme (1967).

Results and Discussion

Physical Evaluation of Cookies

The physical evaluation of cookies based on the weights, thickness, spread ratio (D/T) and spread factor (SF) were studied to ascertain the effects of incorporating Roselle seed flour and Roselle seed oil on the physical attributes and characteristics in the final cookie product (Tables 1 to 3). The results showed that increase amount of Roselle seed flour in cookie was observed to decrease the spread factor of the cookies (Nyam *et al.* 2014), due to reduction in gluten content as gluten gives strength to dough, and during baking dough with low gluten structure will not give an extensive product spread; hence the likely reason for decreased spread factor in cookies with increase additions of Roselle seed flour (Tables 1 to 3). The inclusion of Roselle seed oil was also observed to reduce the spread factor because oil emulsion could reduce the viscoelastic property of gluten structure in a dough mix; as more enhancements in the elastic network of gluten is formed in the aqueous phase than in oil based emulsions (Bengoechea *et al.*, 2006); in effect the product made from dough with low gluten structures will result in softer cookies.

Summary of spread factor of cookies with highest scores in the hedonic test results showed that after the control cookie with a spread factor of 34.5, SD_2 was next with 32.8 followed by UD_2 with 32.0 and RO_3 with 31.1 for SDRSF, UDRSF and RSO at 15 % Roselle seed flour and Roselle seed oil inclusion respectively. The results obtained showed a significant difference ($p<0.05$) in all the treatments when compared to control cookie, except for SD_1, UD_1 and RO_1 respectively (Tables 1 to 3).

Table 1: Effect of different level SDRSF on the physical characteristics of cookies

Treatment	Weight (g)	Diameter (D) mm	Thickness (T) mm	Spread Ratio (D/T)	Spread Factor
SD_0	4.89	31.72	9.19	3.45	34.5
SD_1	4.84	31.16	9.23	3.38	33.8
SD_2	**4.78**	**30.70**	**9.35**	**3.28**	**32.8**
SD_3	4.54	30.35	9.48	3.20	32.0
SD_4	4.39	30.04	9.65	3.11	31.1
SE(±)	0.02	0.16	0.03		
CD at 5 %	0.06	0.50	0.09		
CV %	0.87	1.07	0.65		

Each value is an average of four determinations. SDRSF = Sprouted Decorticated Roselle Seed Flour.

Table 2: Effect of different level UDRSF on the physical characteristics of cookies

Treatment	Weight (g)	Diameter (D) mm	Thickness (T) mm	Spread Ratio (D/T)	Spread Factor
UD_0	4.89	31.72	9.19	3.45	34.5
UD_1	4.83	31.13	9.32	3.34	33.4
UD_2	**4.76**	**30.47**	**9.53**	**3.20**	**32.0**
UD_3	4.52	30.35	9.64	3.15	31.5
UD_4	4.33	30.29	9.76	3.10	31.0
SE(±)	0.06	0.17	0.04		
CD at 5 %	0.17	0.52	0.11		
CV %	2.37	1.11	0.75		

Each value is an average of four determinations. UDRSF = Un-sprouted Decorticated Roselle Seed Flour.

Table 3: Effect of different level RSO on the physical characteristics of cookies

Treatment	Weight (g)	Diameter (D) mm	Thickness (T) mm	Spread Ratio (D/T)	Spread Factor
RO_0	4.89	31.72	9.19	3.45	34.5
RO_1	4.82	30.05	9.30	3.23	32.3
RO_2	4.72	29.89	9.43	3.17	31.7
RO_3	**4.69**	**29.81**	**9.57**	**3.11**	**31.1**
RO_4	4.55	29.76	9.65	3.08	30.8
RO_5	4.36	29.71	9.70	3.06	30.6
RO_6	4.18	29.35	9.76	3.01	30.1
SE(±)	0.03	0.17	0.02		
CD at 5 %	0.09	0.51	0.06		
CV %	1.56	1.37	0.54		

Each value is an average of four determinations. RSO = Roselle Seed Oil.

Sensory Evaluation of Cookies

Sensory study of cookies with the addition of varying percentages of pretreated Roselle seeds flour and oil were evaluated. Panels of 20 semi-trained panelists were employed to test the cookie products and record effective responses based on 9 point hedonic scale to evaluate the attributes of appearance, flavour, taste, crispiness and overall acceptability (Tables 4 to 6).

For Un-sprouted Decorticated Roselle Seed Flour (UDRSF)

UD_2 ranked the highest for overall acceptability of 8.6, followed by UD_3 8.22, UD_o 8.20, UD_4 8.14; while UD_4 had the minimum score of 7.7. The result score for appearance ranged from 7.4 to 8.14 with UD_0 being the most appealing to sight 8.14 and UD_4 had the least 7.4. Results for flavour showed UD_2 had 8.47 the highest while UD_4 had 7.4 the lowest score (Table 4). The score range for crispiness showed UD_2 having the score 8.2 while UD_4 had the least score 7.66. For taste attribute UD_o had the highest 8.4 while UD_4 had the least with a score of 7.58. The score for appearance, flavour, crispiness and taste showed that there was a significant difference ($p<0.05$) between cookies made from the composite flour mix and wheat flour. UD_2 (15-85%) formulation had the most superior quality attributes in the final baked products (Table 4).

Table 4: Organoleptic evaluation of cookies prepared from UDRSF

Sample Code	Appearance	Flavour	Crispiness	Taste	Overall acceptability	Rank
UDo	8.14	7.78	8.78	8.40	8.20	3
UD_1	7.88	8.07	8.30	8.00	8.14	4
UD_2	**7.88**	**8.47**	**8.20**	**8.38**	**8.60**	**1**
UD_3	7.82	7.95	8.19	8.12	8.22	2
UD_4	7.40	7.50	7.66	7.58	7.70	5
SE(±)	0.02	0.03	0.02	0.02	0.01	
CD@5 (%)	0.07	0.09	0.07	0.07	0.06	
CV (%)	0.62	0.79	0.53	0.54	0.46	

Where: (UDo) as Control; (UD_1) 10-90 %; (UD_2) 15-85 %; (UD_3) 20-80 %; and (UD_4) 25-75 % RSF replacement respectively. UDRSF = Un-sprouted Decorticated Roselle Seed Flour.

For Un-sprouted Decorticated Roselle Seed Flour (SDRSF)

SD_2 ranked the highest for overall acceptability of 8.9, followed by SD_3 8.27, SD_1 8.14, SD_0 8.0; while SD_4 had the minimum score of 7.75. The Score for appearance, flavour, crispiness and taste showed that there was a significant difference ($p<0.05$) between cookies made from the composite flour mix and wheat flour (Table 5). The score for appearance ranged from 7.56 to 8.26. SD_0 ranked highest with 8.26 followed by SD_2 8.0, SD_3 7.9, SD_1 7.89 and SD_4 having the least score of 7.56. For flavour SD_2 had the highest 8.45 while SD_4 had the lowest 7.4. For crispiness SD_2 had the highest 8.5 while SD_4 had the lowest 7.99. For taste SD_2 had the highest 8.5 while SD_4 had the lowest 7.9. The Score for appearance, flavour, crispiness and taste showed that there was a significant difference ($p<0.05$) between cookies made from the composite flour mix and wheat flour. Cookie SD_2 with formulation 15-85% had the most superior quality attributes in the final baked products (Table 5).

Table 5: Organoleptic evaluation of cookies prepared from SDRSF

Sample Code	Appearance	Flavour	Crispiness	Taste	Overall acceptability	Rank
SD_0	8.26	7.70	8.14	8.00	8.00	4
SD_1	7.89	7.49	8.20	8.50	8.14	3
SD_2	**8.00**	**8.45**	**8.50**	**8.54**	**8.90**	**1**
SD_3	7.90	8.13	8.30	8.50	8.27	2
SD_4	7.56	7.40	7.99	7.90	7.75	5
SE(±)	0.004	0.02	0.02	0.02	0.004	
CD at5 %	0.01	0.06	0.06	0.05	0.01	
CV (%)	0.11	0.46	0.45	0.45	0.09	

Where: (SD_0) as Control; (SD_1) 10-90 %; (SD_2) 15-85 %; (SD_3) 20-80 %; and (SD_4) 25-75 % RSF replacement respectively. SDRSF = Sprouted Decorticated Roselle Seed Flour.

For Roselle Seed Oil (RSO)

RO_3 ranked the highest for overall acceptability of 8.3, followed by RO_2 8.13, RO_1 8.12, RO_0 and RO_4 8.0 at per; RO_6 7.46; while RO_6 had the minimum score of 6.47. The score for appearance, flavour, crispiness and taste showed that there was a significant difference ($p<0.05$) cookies made from replacing margarine with Roselle seed oil. For appearance RO_0 had the highest 8.30, while RO_6 had the least 7.01. For flavour RO_3 had the highest 8.42 while RO_6 had the least score 6.9. For crispiness RO_3 had the highest 8.63 while RO_6 had the lowest 6.64. For taste RO_6 had the highest 8.9 while RO_6 had the lowest 6.0 score reason could be that the panelists are not use to the aroma and taste of Roselle seed oil since the oil is novel, as it is not widely known. The score for appearance, flavour, crispiness and taste showed that there was a significant difference ($p<0.05$) between cookies made from substituting margarine with Roselle seed oil and control with just margarine. Cookie RO_3 with formulation 15-35% had the most superior quality attributes and acceptability in the overall final baked products (Table 6).

Table 6: Organoleptic evaluation of cookies prepared from RSO

Sample Code	Appearance	Flavour	Crispiness	Taste	Overall acceptability	Rank
RO_0	8.30	8.10	8.20	8.00	8.00	4
RO_1	8.22	8.11	8.00	8.09	8.12	3
RO_2	8.17	8.02	8.00	8.23	8.13	2
RO_3	**7.94**	**8.42**	**8.63**	**8.90**	**8.30**	**1**
RO_4	8.20	8.00	8.45	8.40	8.00	4
RO_5	7.43	7.54	6.93	7.82	7.46	6
RO_6	7.01	6.90	6.64	6.00	6.47	7
SE(±)	0.004	0.02	0.04	0.03	0.02	
CD at 5 %	0.01	0.06	0.13	0.10	0.06	
CV (%)	0.13	0.57	1.35	1.05	0.65	

Where: (ROo) as Control; (RO_1) 5-45 %; (RO_2) 10-40 %; (RO_3) 15-35 %; (RO_4) 20-30%; (RO_5) 25-25 % and (RO_6) 30-20 % RSO replacement respectively at 50% standard recipe formulation.

Colour of Cookie

The results showed that cookie products becomes darker (L*), less red (a*) and less yellow (b*) with inclusion of Roselle seed flours and oil in at 10%, 15%, 20%, 25% and 5%, 10%, 15%, 20%, 25%, 30% for the pair of SDRSF, UDRSF and RSO respectively (Tables 7 to 10). The results showed that there was a significant difference ($p<0.05$) between cookies made from Roselle seed flour blends, Roselle seed oil and wheat flour as control respectively.

The summary of the total colour difference (ΔE*) for selected cookies in sensory evaluation Table 10 showed SDRSF at 15-85 ratio having the highest colour difference with ΔE* value 5.12 followed by UDRSF 3.87 and RSO15-35 ratio 1.26 (Table 10). The high value for SDRSF 15-85 ratio could be due to the combined effects of enzymatic browning due to sprouting, non-enzymatic browning (maillard reaction between reducing sugars and amino acids), starch dextrination and sugar caramelization during baking (Gomez *et al.*, 2008; Zucco *et al.*, 2011).

Texture Analysis of Cookies

Texture testing is a well-established technique for evaluating the mechanical and physical properties of raw ingredients and food structure and is a property that relates to the sense of touch and can be measured easily by mechanical methods in units such as force (N). In these studies a texturometer was used to measure the crushing, cutting and penetration force calculated at entire area of the cookie samples the results summary obtained are outlined Table 11 and Figure 1. The results showed that crushing, cutting and penetration force needed to break the cookies decreased with the incorporation of Roselle seed flour. The control sample had the highest value followed by 10, 15, 20 and 25% respectively. The results showed that there was significant difference ($p<0.05$) in texture between cookies made from the composite flour blend and wheat flour as control.

Table 7: Effects of addition of *SDRSF on total colour difference of cookie

Colour Space	Treatments for SDRSF cookies					Delta of Colour Space	Total colour difference			
	Control	10	15	20	25		10	15	20	25
L*	68.61	67.20	66.73	66.63	66.31	ΔL*	-1.41	-1.88	-1.98	-2.30
a*	5.85	5.19	4.79	4.75	4.44	Δa*	-0.66	-1.06	-1.10	-1.41
b*	24.22	20.65	19.58	19.42	18.53	Δb*	-3.57	-4.64	-4.80	-5.69
SE(±)	0.66	0.30	0.12	0.09	0.10	ΔE*	3.89	5.12	5.31	6.29
CDat5 (%)	1.96	0.86	0.35	0.28	0.30	Comments				
CV (%)	2.84	1.36	0.56	0.44	0.48	ΔL*	Darker	Darker	Darker	Darker
						Δa*	<Red	<Red	<Red	<Red
						Δb*	<Yellow	<Yellow	<Yellow	<Yellow

*Spouted Decorticated Roselle Seed Flour (SDRSF); each value is an average of seven determinations.

Table 8: Effects of addition of *UDRSF on total colour difference of cookie

Colour Space	Treatments for UDRSF cookies					Delta of Colour Space	Total colour difference			
	Control	10	15	20	25		10	15	20	25
L*	68.61	67.58	67.06	66.52	66.42	ΔL*	-1.03	**-1.55**	-2.09	-2.20
a*	5.85	5.73	5.57	5.09	4.61	Δa*	-0.12	**-0.28**	-0.76	-1.24
b*	24.22	21.81	20.69	19.01	18.96	Δb*	-2.41	**-3.53**	-5.21	-5.26
SE(±)	0.66	0.40	0.59	1.01	0.68	**ΔE***	2.62	**3.87**	5.66	5.84
CDat5 (%)	1.96	1.20	1.76	3.01	2.01	Comments				
CV (%)	2.84	1.80	2.70	4.75	3.19	ΔL*	Darker	Darker	Darker	Darker
						Δa*	<Red	<Red	<Red	<Red
						Δb*	<Yellow	<Yellow	<Yellow	<Yellow

*Un-sprouted Decorticated Roselle Seed Flour (UDRSF); each value is an average of seven determinations.

Table 9: Effects of addition of RSO on total colour difference of cookie

Colour Space	Treatments for RSO cookies							Delta of Colour Space	Total colour difference					
	Control	5	10	15	20	25	30		5	10	15	20	25	30
L*	68.61	68.27	68.21	68.20	67.80	67.77	67.55	ΔL*	-0.34	-0.41	-0.42	-0.81	-0.84	-1.06
a*	5.85	5.67	5.47	4.99	4.90	4.68	4.25	Δa*	-0.17	-0.38	**-0.86**	-0.95	-1.17	-1.60
b*	24.22	23.51	23.44	23.39	22.30	22.26	21.17	Δb*	-0.71	-0.78	**-0.83**	-1.92	-1.96	-3.05
SE(±)	0.66	0.06	0.16	0.06	0.08	0.10	0.25	**ΔE***	0.80	0.96	**1.26**	2.29	2.43	3.60
CD@5 (%)	1.96	0.17	0.46	0.17	0.25	0.29	0.74	Comments						
CV (%)	2.84	0.25	0.68	0.24	0.37	0.44	1.13	ΔL*	Darker	Darker	Darker	Darker	Darker	Darker
								Δa*	<Red	<Red	<Red	<Red	<Red	<Red
								Δb*	<Yellow	<Yellow	<Yellow	<Yellow	<Yellow	<Yellow

*Roselle Seed Oil (RSO); each value is an average of seven determinations.

Table 10: Summary of total colour difference of cookies with highest scores in the hedonic test.

Colour Space	Total Colour Difference		
	SDRSF 15-85	UDRSF 15-85	RSO 15-35
ΔL*	-1.88	-1.55	-0.42
Δa*	-1.06	-0.28	-0.86
Δb*	-4.64	-3.53	-0.83
ΔE*	5.12	3.87	1.26

SDRSF = Sprouted Decorticated Roselle Seed Flour; UDRSF = Un-sprouted Decorticated Roselle Seed Flour; RSO = Roselle Seed Oil.

Table 11: Summary of texture profile of cookies with highest scores in the hedonic test.

Treatment	Crushing Force (N)	Cutting Force (N)	Penetration Force (N)
CONTROL	69.13	78.18	39.60
SDRSF (15-85 ratio)	55.50[1]	49.83[2]	22.84[1]
UDRSF (15-85 ratio)	38.29[3]	63.86[1]	26.06[3]
RSO (15-35 ratio)	46.23[2]	44.85[3]	24.67[2]

Ranked 1, 2, 3 for each parameter. NB: Treatments details as – SDRSF = Sprouted Decorticated Roselle Seed Flour; UDRSF = Un-sprouted Decorticated Roselle Seed Flour; RSO = Roselle Seed Oil.

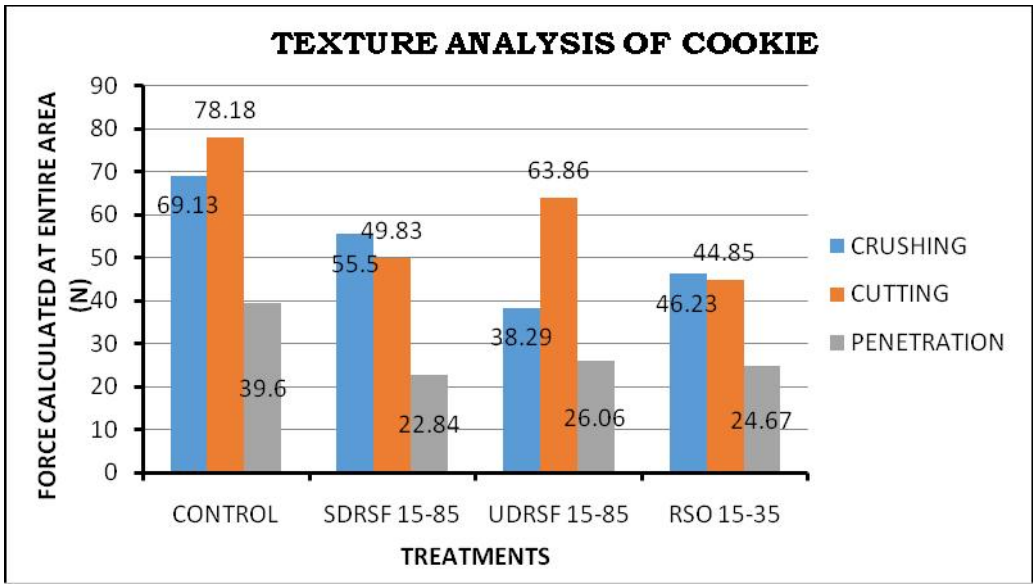

Figure 1: Texture profiles of cookies with the highest scores in hedonic test. SDRSF = Sprouted Decorticated Roselle Seed Flour; UDRSF = Un-sprouted Decorticated Roselle Seed Flour; RSO = Roselle Seed Oil.

The difference could be as a result of decrease in gluten content in the composite flour as Roselle seed flour is added; flour with low gluten produce a low extensive gluten structure which will result in softer cookies (Ajila *et al.*, 2008). The same decrease was recorded in cookie samples in which margarine was replaced with Roselle seed oil at 5, 10, 15, 20, 25 and 30%.

Conclusion

The overall summary of texture profile showed that the crushing force (N) for SDRSF 15-85% ranked highest when compared to control, followed by UDRSF 15-85% and RSO 15-35%. For cutting force (N), UDRSF 15-85% ranked highest followed by SDRSF 15-85% and RSO 15-35%. For penetration force (N), SDRSF 15-85% ranked the highest followed by RSO 15-35% and UDRSF 15-85%. The summary results showed that there was a significant difference ($p<0.05$) between cookies made from Roselle seed flour and oil blends compared to the control (Table 11 and Figure 1).

References

Ajila, C.M., Leelavathi, K. and Prasada Rao U.J.S. (2008). Improvement of dietary fibre content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. *J Cereal Sci* 48: 319-326.

Amerine, M. A., Pangborn, R. M. and Rossler, E.B. (1980). Principles of sensory evaluation of food. Academic Press, New York.

Arshad, M. U., Anjum, F. M. and Zahoor, T. (2007). Nutritional assessment of cookies supplemented with defatted wheat germ. *Food Chemistry*, 102, 123–128.

Bala, A., Gul, K. and Riar, C. S. (2015). Functional and sensory properties of cookies prepared from wheat flour supplemented with cassava and water chestnut flours. *Cogent Food and Agriculture*, 1, 1019815.

Bambgoye, A.I. and Adejumo, O.I. (2009). Physical Properties of Roselle (*Hibiscus sabdariffa L.*) *Seed.* Agricultural Engineering International: the CIGR Ejournal. Manuscript 1154.Vol. XI.

Bengoechea, C., Cordobés, F. and Guerrero, A. (2006). Rheology and microstructure of gluten and soya-based o/w emulsions, *Rheologica Acta*, Volume 46, issue 1, pp 13-21.

Bertagnolli, S. M. M., Silveira, M. L. R., Fogaça, A. D. O., Umann, L. and Penna, N. G. (2014). Bioactive compounds and acceptance of cookies made with Guava peel flour. *Journal of food science Technology*, 34, 303–308.

Curtis; Rajaraman; MacPherson (2002). Bread Wheat. Food and Agricultural Organization of the United Nations

Gomez, M., Oliete, B., Rosell, C. M., Pando, V. and Fernande, E. (2008). Studies on cake quality made of wheat–chcikpea flour blends. *LWT-Food Science and Technology*, 41, 1701–1709.

Gunstone D.F. (2002). Vegetable Oils in food technology: Composition, properties and uses. London: *Blackwell Publishing Ltd;*337pp

Hussain, S., Anjum, F.M., Butt, M.S., Khan, M.I. and Asghar, A. (2006) Physical and sensoric attributes of flaxseed flour supplemented cookies. Turk J Biol 30:87-92.

Karma Bako Rimamcwe and Chavan, U. D. (2016). Physical properties and nutritional potentials of Indian Roselle (*Hibiscus sabdariffa* L.) seeds. International Journal of Current Research. 8 (9): 38644-38648.

Karma Bako Rimamcwe and U.D. Chavan (2017). Antioxidant Activity and Nutritional Value of Roselle Seeds Flour. Int. J. Curr. Microbiol. App. Sci. 6(4): 2654-2663.

Karma Bako Rimamcwe, Chavan, U. D., Nimbalkar, C. A. and Kahar, S. P. (2017a). Rheometry of Roselle (*Hibiscus Sabdariffa* L.) seed oil. Int. J. Pure App. Biosci. 5 (2): 987-993.

Karma Bako Rimamcwe, Chavan, U. D., Pawar, G. H. and Gaikwad, R. S. (2017b). Nitrogen Solubility and Functional Properties of Roselle Seed Flour. Int. J. Curr. Microbiol. App. Sci. 6(8): 1131-1139.

Karma Bako Rimamcwe, Chavan, U. D., Dalvi, U. S. and Gaikwad, R. S. (2017c). Nutritional quality of Roselle seed flour cookies. International Journal of Current Research. 9: (12): 63053-63058.

Konica (2016). *Konica Minolta Sensing Americas, Inc*. Online source: www.sensing.konicaminolta.us

Myfolia.com (2016), online source: https://myfolia.com

Nyam, K. L, They, Y. N., Tan, C. P. and Kamariah, L., (2012). *In-vitro* Antioxidant Activities of Extract and Oil from Roselle (*Hibiscus sabdariffa L.*) Seed against Sunflower Oil Autoxidation, *Mal J Nutri* 18(2): 265-274.

Nyam, Kar-Lin; Leao, Sod-Ying; Tan, Chin-Ping; and Long, Kamariah (2014). Functional Properties of Roselle (Hibiscus sabdariffa L.) seed and its application as bakery product, J. Food Sci. Technol 51(12):3830-3837 DOI 10.1007/s13197-012-0902-x

Okafor, J. N., Ozumba, A. U. and Solomon, H. M. (2002). Production and acceptability of chinchin fortified with oyster mushroom. *Nigeria Food Journal*, 18, 19–20.

Panse, V.G. and Sukhate, P.V. (1967). Statistical methods for Agricultural Workers. 4th ed., New Delhi

Ramadan M.F. and Morsel J.T. (2004). Oxidative stability of black cumin (*Nigella sativa L.*), coriander (*Coriandrum sativum L.*) and niger (*Guizotia abyssinica Cass.*) crude seed oils upon stripping. *Eur J Lipid Sci Technol*; 106: 35-43.

USDA (2016). National Nutrient Database for Standard Reference Release 28, available online: https://ndb.nal.uSEa.gov

Wani, S. H., Gull, A., Allaie, F., and Safapuri, T. A. (2015). Effects of incorporation of whey protein concentrate on physicochemical, texture, and microbial evaluation of developed cookies. *Cogent Food and Agriculture, 1*, 1092406.

Wikipedia (2016). Roselle (plant). Available online: http://en.wikipedia.org/wiki/Hibiscus_sabdariffa.

Yayock, J.Y., Lombin, G. and Owonubi, J.J. (1988) Crop Science and Production in Warm Climates. Macmillan Publishers, London, p.307

Zucco, F., Borsuk, Y. and Arntfield, S. D. (2011). Physical and nutritional evaluation of wheat cookies supplemented with pulse flours of different particle sizes. *LWT-Food Science and Technology*. doi:10.1016/j.lwt.2012.02.028

Access this Article in Online

Website: www.ijarbs.com

Subject: Food Technology

Quick Response Code

DOI:10.22192/ijarbs.2018.05.05.016

How to cite this article:
Karma Bako Rimamcwe, U. D. Chavan, S. B. Lande, C. A. Nimbalkar and U. S. Dalvi. (2018). Physical and sensory quality of Roselle seed flour cookies. Int. J. Adv. Res. Biol. Sci. 5(5): 160-171.
DOI: http://dx.doi.org/10.22192/ijarbs.2018.05.05.016