International Food Research Journal 20(2): 587-591 (2013)
Journal homepage: *http://www.ifrj.upm.edu.my*

Effect of replacement of wheat flour with pumpkin powder on textural and sensory qualities of biscuit

[1*]Kulkarni, A.S. and [2]Joshi, D.C.

[1]Department of Food Processing Technology, A.D. Patel Institute of Technology, PO Box No. 52, New V V Nagar, Anand – 388 121, India
[2]Faculty of Food Processing Technology, AAU, Anand-388110, India

Article history

Received: 6 October 2011
Received in revised form: 3 January 2012
Accepted:3 January 2012

Keywords

Wheat flour
biscuits
pumpkin powder
carotene
texture
sensory

Abstract

Biscuits were prepared by replacing wheat flour with pumpkin powder at different levels viz. 0, 2.5, 5.0 7.5 and 10% (w/w) in the standard formulation. The influence of replacement of wheat flour in biscuit with pumpkin powder in the formulation of biscuit resulted in a significant change in the textural and sensory qualities of biscuits. As the replacement level of wheat flour with pumpkin powder increased from 0 to 10% (w/w), the hardness and fracturability was increased. Biscuit prepared by replacing wheat flour with pumpkin powder at the level of 2.5% (w/w) was found to be more acceptable from sensory point of view and thereafter sensory score was reduced. Biscuits with more pumpkin powder had a more yellow color than those with less pumpkin powder. Adding more pumpkin powder increased the level of carotene in the biscuits.

Introduction

Wheat has been used in a variety of food products such as bread, biscuits, cakes, crackers (Lee *et al*., 2002; Pongjanta *et al*., 2006). Among all the bakery products, biscuit which is prepared from wheat flour is more popular among the all age group population. Biscuits are generally prepared from the hard wheat flour dough. Qualities of the biscuits such as baking properties, color, taste and texture are more important affecting the consumer acceptance. In recent years, biscuits are fortified with various nutrients to enrich them to become a complete food with all necessary nutrients. The base material used for the preparation of biscuit i.e. wheat flour contains a limited amount of β-carotene which is considered as precursor of vitamin A which is available in variety of fruits and vegetables (Tee and Lim, 1991; Olson,1989). In the present context, an attempt has been made to enhance the level of β – carotene in biscuit by using pumpkin powder as a source of β-carotene. Pumpkins are extensively grown in tropical and subtropical countries where it traditionally consumed as freshly boiled and steamed or as a processed food items such as soup or curry. Pumpkin is high in β-carotene, which gives its yellow or orange color (Bhaskarachary *et al*., 2008). β -carotene in plants that have pleasant yellow-orange color is a major source of vitamin A (Lee, 1983). Consumption of foods containing carotene helps in prevention of eye disorders, cancer and skin diseases (Bendich, 1989). Incorporation of β-carotene rich foods in diets is the best measure to improve vit A nutrition of individuals to overcome the problems and diseases caused by Vitamin A Deficiency (VAD) (Chandrashekhar and Kowsalya, 2002; Siems *et al*., 2005). The pumpkin powder was prepared from the flesh of pumpkin by vacuum drying technique in this study. The objective of this study undertaken was to determine the optimum level of substitution of carotene rich pumpkin powder in the formulation of biscuit and to assess the effect of pumpkin powder added to biscuit on sensory and textural characteristics of biscuit.

Material and Methods

Materials

The matured pumpkin (*Cucurbita maxima*, Var. MPH-1) fruits were procured from the research farm of Anand Agricultural University, Anand and ingredients for biscuit were purchased from the local market. Authentic β-carotene (Himedia) was used as the standard. All chemicals used in the experiment were of analytical grade from reputed manufacturers.

*Corresponding author.
Email: *anant_food@rediffmail.com*

Pumpkin powder production

The peeled pumpkin fruit was converted into 10mm size cubes and subjected for pretreatments such as blanching (temperature 94^{O}C, time 2 min.) and sulphitation carried out in 500 ppm solution of $K_2S_2O_3$ prior to drying. The pretreated cubes of pumpkin fruit were dried for preparation of powder using vacuum dryer. Vacuum drying of pumpkin cubes was carried out at 80^{O}C and 700 mm Hg vacuum. The Pumpkin powder was analyzed for carotene content.

Preparation of biscuit

The biscuits were made in the pilot bakery of Anand Agricultural University, Anand using the standard recipe consisting of refined wheat flour 100g, sugar 50g, fat 60 g, sodium bicarbonate 0.5 g, custard powder 2 g (Kamaliya and Kamaliya, 2001). For the experiments biscuits were prepared by replacing wheat flour with pumpkin powder at different levels viz. 0, 2.5, 5.0 7.5 and 10% (w/w) in the standard formulation. Baking was carried out at 175^{0}C for 12 min. The chemical and sensory properties of the pumpkin powder substituted samples were determined and compared with control sample. Moisture, protein, fat, carbohydrate, ash, crude fibre, ascorbic acid, total carotene, calcium, phosphorus, iron and potassium were analyzed using the methods in AOAC (1990).

Texture analysis

Different samples of biscuits as prepared above were studied for the effect of replacement of refined wheat flour with pumpkin powder for its fracturability and hardness using Texture Analyzer (Stable Microsystems, UK, Model TAHDi). The measurement of each sample was done in triplicate.

Sensory evaluation

Sensory parameters such as appearance, taste, flavor, color, texture and overall acceptability were evaluated by trained panel from academic staff and food industry consisting of 6 persons using 9-point hedonic scale (from like extremely = 9 to dislike extremely = 1) (Watts *et al*., 1989).

Statistical analysis

Statistical analysis was carried out using Complete Randomized Design (CRD) giving analysis of variance (AVOVA) for significance at 5% of each treatment (Panse and Sukhatme, 1985).

Results and Discussion

Effect of replacement of refined wheat flour with pumpkin powder on textual quality of biscuit

Replacement of refined wheat flour with pumpkin powder in the formulation of biscuit resulted in a significant change in the textual quality of the biscuits. Figures 1 and 2 illustrate the effect of replacement of refined wheat flour with pumpkin powder on the textual quality i.e. hardness and fracturability of biscuit. It is evident from the data that as the replacement level of pumpkin powder was increased from 0 to 10%, the amount of force required to break the biscuit increased considerably. On replacing 2.5% of refined wheat flour with pumpkin powder, the hardness of the biscuits increased to 2573 g from that of 2476 g for the control sample. Further increase in replacement level to 5.0, 7.5 and 10 % of refined wheat flour by pumpkin powder, increased the hardness of biscuit to the further level of 2853, 3009 and 3263 g, respectively.

Similarly, increasing the replacement level of refined wheat flour with pumpkin powder, the amount of force required to give first crack on the biscuit while breaking i.e. fracturability also increased. The fracturability of plain control sample of biscuit was 0.82 mm, but as the replacement level of refined wheat flour with pumpkin powder was increased to 2.5, 5.0, 7.5 and 10%, the fracturability of biscuit increased to 0.97, 1.25, 1.46 and 1.74 mm, respectively.

These phenomena of gradual increase in hardness and fracturability with increase in replacement level of refined wheat flour with pumpkin powder might be due to the fact that water absorption capacity of refined wheat flour is more as compared to that of the pumpkin powder. Hence, during baking the optimum moisture could not retained in the biscuit as the carbohydrate content was increased due to the addition of pumpkin powder to replace the refined wheat flour.

Effect of replacement level of refined wheat flour with pumpkin powder on sensory quality of biscuit

The mean scores of different sensory parameters of biscuits prepared by replacing refined wheat flour with pumpkin powder at different levels are presented in Table 1.

Appearance

The mean score for appearance of biscuit varied from 5.76 to 7.85 with different levels of replacement of refined wheat flour with pumpkin powder. It was observed that the biscuit sample prepared by replacing refined wheat flour at 2.5% (w/w) with pumpkin powder scored the maximum (7.85) and high over the

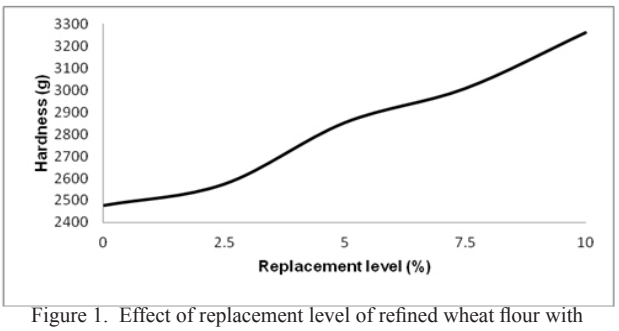

Figure 1. Effect of replacement level of refined wheat flour with pumpkin powder on hardness of biscuit.

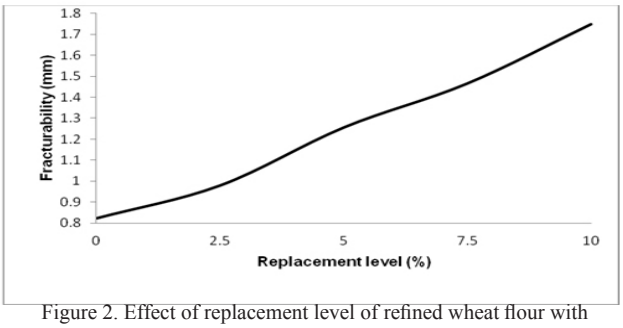

Figure 2. Effect of replacement level of refined wheat flour with pumpkin powder on fracturability of biscuit.

Table 1. Mean sensory score for biscuit prepared by replacing refined wheat flour with pumpkin powder

Replacement level (%)	Sensory score					
	Appearance	Taste	Flavor	Color	Texture	Overall acceptability
0 (Control)	6.63	6.73	6.70	6.92	6.79	6.74
2.5	7.85	8.66	7.61	7.84	7.76	7.97
5.0	6.89	6.93	6.51	6.78	6.58	6.79
7.5	6.24	6.06	5.86	6.00	5.85	5.77
10.0	5.76	5.46	5.29	5.39	5.71	5.28
CV (%)	12.25	28.21	13.47	12.73	13.98	10.50

Table 2. Chemical composition of biscuit with optimized level of replacement of refined wheat flour with pumpkin powder

Sr. No.	Constituent	Control sample	Optimized sample
1	Moisture (%)	2.47±0.03	2.31±0.07
2	Carbohydrate (%)	64.47±0.08	64.81±0.03
3	Protein (%)	5.48 ± 0.03	5.03 ± 0.06
4	Fat (%)	27.11±0.04	27.12±0.20
5	Crude fibre (%)	Nil	0.09±0.00
6	Ash (%)	0.40±0.01	0.50±0.01
7	Carotene (µg/100 g)	Nil	208 ±5.65
8	Calcium (%)	0.16±0.02	0.17±0.04
9	Phosphorous (%)	0.04 ±0.00	0.04±0.00
10	Potassium (%)	0.06±0.01	0.07±0.00
11	Iron (ppm)	21 ± 4.24	32 ± 1.41

Values are mean ± standard deviation of three determinations

control. Replacement level beyond 2.5%, reduced the liking of the product gradually from appearance point of view. As the level of replacement was increased from 2.5 to 10.0 %, the appearance of the biscuit became inferior.

Taste

The mean score for taste varied from 5.46 to 8.66 with different levels of replacement of refined wheat flour with pumpkin powder. It was observed that biscuit prepared by replacing 2.5% (w/w) refined wheat flour with pumpkin powder scored the maximum (8.66) and high over the control. It is evident from the score that increase in replacement level beyond 2.5% was not liked from taste point of view. As replacement level was increased from 2.5 to 10.0%, the gradual increase in bitterness was observed.

Flavor

The mean score for flavor ranged between 5.29 and 7.61 with different levels of replacement of refined wheat flour with pumpkin powder. It was observed that the biscuit sample prepared by replacing refined wheat flour at 2.5% with pumpkin powder scored the maximum score of 7.61 and high over the control. It is evident from the data that replacement level of 2.5% was much accepted with flavor point of view in biscuit. Flavor likeness in sample with replacement level beyond 2.5 % was reduced as there was increase in oily flavor.

Color

The mean score for color varied from 5.39 to 7.84. The maximum and the minimum values corresponded to biscuit samples prepared by replacing refined wheat flour with pumpkin powder at the level of 2.5 and 10.0%, respectively. It was observed that the biscuit sample prepared by replacing refined wheat flour at 2.5% with pumpkin powder scored the maximum score of 7.84 and high over the control. Increase in replacement level of refined wheat flour with pumpkin powder beyond 2.5% reduced the likeness of biscuit with color point of view as the color became gradually darker with increase in replacement level.

Texture

The mean score for texture varied from 5.71 to 7.76. The maximum and the minimum value corresponded to the samples of biscuit prepared by replacing refined wheat flour with pumpkin powder at the level of 2.5 and 10.0%, respectively. The sensory score for texture decreased gradually with increase in replacement level. Replacement level beyond 2.5% reduced the liking of the product gradually from texture point of view. As the level of replacement was increased from 2.5 to 10.0%, the texture of the biscuit became inferior due to the gradual increase in hardness. It is also evident from the data mentioned in Figure 1 that hardness of biscuit increased with increase in replacement level.

Overall acceptability

The mean score for overall acceptability varied from 5.28 to 7.97. The maximum value corresponded to the sample prepared with a replacement level of 2.5% of refined wheat flour with pumpkin powder which was having score of 7.97, while the sample prepared with a replacement level of 10.0% of refined wheat flour with pumpkin powder scored the minimum (5.28). It was observed that the minimum replacement level of 2.5% (w/w) of refined wheat flour with pumpkin powder was more accepted and scored high. The liking for biscuit samples prepared with replacement level beyond 2.5% was gradually decreased with increase in replacement level as they were found inferior in appearance, taste, flavor, color and texture.

It was observed that more than 2.5% replacement of refined wheat flour with pumpkin powder in biscuit formulation had a strong influence on sensory properties of the biscuit. ANOVA was carried out for the whole sensory data and is presented in Table 1. The results showed that increasing replacement level from 0 to 10% (w/w) of refined wheat flour with pumpkin powder had a significant influence (at 5% level of significance) on appearance, taste, flavor, color, texture and over acceptability of the biscuit sample as the calculated F values (Fc) were more than tabulated F values (Ftab) for all these sensory parameters.

Chemical composition of biscuit

The 2.5% replacement level of refined wheat flour with pumpkin powder in the biscuit was judged as best from sensory point of view. A biscuit sample with the optimized level (2.5%) of replacement of refined wheat flour with the pumpkin powder was prepared. The chemical composition of the optimized sample as well as the control sample was determined (Table 2).

The results indicate that the carbohydrate in optimized sample of biscuit was higher over the control sample (64.81% to 64.47%). Moisture content of the biscuit decreased after replacing refined wheat flour with pumpkin powder over the control sample from 2.47+0.03 to 2.31+0.07%. Water absorption capacity of pumpkin powder was less as compared to refined wheat flour, which might be responsible for texture particularly hardness, hence hardness and fracturability of optimized sample has been increased.

On the other hand, the protein content of optimized sample was lower over the control sample (5.03 + 0.06% to 5.48 + 0.03%). This might be due to the fact that the protein rich refined wheat flour was replaced by the carbohydrate rich pumpkin powder in the preparation of product. The control sample was also found deficient in crude fibre. But, due to the replacement of refined wheat flour with pumpkin powder, the optimized sample had higher crude fibre. Fat content remained same in both the samples. Ash content in optimized sample was higher over the control sample (0.50 + 0.01% to 0.40 + 0.01%) and hence, the minerals such as calcium, phosphorous and iron were more in the optimized biscuit sample as compared to the control sample. Carotene was absent in control sample but due to 2.5 % (w/w) replacement of refined wheat flour with pumpkin powder in the final biscuit, the carotene content increased to 208 µg/100g. This is very important considering the increase in the vitamin A value of the product.

Conclusions

This study revealed the effect of replacement of refined wheat flour with pumpkin powder on the textural and sensory qualities of biscuit. The pumpkin powder could be very well utilized to prepare the biscuit. As the replacement level of refined wheat flour with pumpkin powder was increased from 0 to 10% (w/w), the hardness and fracturability of the biscuits so prepared was increased. On the basis of textural and sensory characteristics, the replacement level at 2.5% (w/w) of refined wheat flour with pumpkin powder was found to be optimum for the preparation of carotene enriched biscuits. The biscuit prepared with optimum level of replacement i.e. 2.5% (w/w) of refined wheat flour with pumpkin powder was found to be high in carbohydrate, crude fibre, carotene and mineral matter.

Acknowledgement

The authors gratefully acknowledge the financial support extended by Anand Agricultural University, Anand.

References

AOAC.1990. Association of Official Analytical Chemists. Official Methods of Analysis. 14th Edn., Method 930.04, Method 930.05, Method 970.64, Method 978.04. Washington D.C.

Bendich, A. 1989. Carotenoids and the immune response. Journal of Nutrition 119: 112-115.

Bhaskarachary, K., Ananthan, R. and Longvah, T. 2008. Carotene content of some common (cereals, pulses, vegetables, spices and condiments) and unconventional sources of plant origin. Food Chemistry 106: 85-89.

Chandrashekhar, U. and Kowsalya, S. 2002. Provitamin A content of selected South Indian Foods by high

performance liquid chromatography. Journal of Food Science and Technology 39(2): 183-187.

Kamaliya, M. K. and Kamaliya, K.B. 2001. Baking Science and Industries. 1st Edn. Vol. I & II.

Lee, C. H., Cho, J. K., Lee, S. J., Koh, W., Park, W. and Kim, C. H. 2002. Enhancing β-carotene content in Asian noodles by adding pumpkin powder. Cereal chemistry 79 (4): 593-595.

Lee, F.A. 1983. Basic Food Chemistry.AVI Publisher, Westport.

Olson, J. A. 1989. Provitamin A function of carotenoids: the conversion of β-carotene into vitamin A. Journal of Nutrition 119: 105-108.

Panse, V.G. and Sukhatme, P.V. 1985. Statistical methods for agricultural workers. 2nd Edn. ICAR, New Delhi.

Pongjanta, J., Naulbunrang, A., Kawngdang, S., Manon, T. and Thepjaikat, T.2006. Utilization of pumpkin powder in bakery products. Songklanakarin Journal of Science and Technology 28 (Suppl.1): 71-79.

Siems, S., Wiswedel, I., Salerno, C., Crifo, C., Augustin, L.S., Langhans, C.D. and Sommerberg, O.2005. β-carotene breakdown products may impair mitochondrial functions – Potential side effects of high dose β-carotene supplementation. Journal Nutritional Biochemistry 16: 385-397.

Tee, E.S. and Lim, C.L. 1991. Carotenoids composition and content of Malaysian vegetables and fruits by AOAC and HPLC methods. Food Chemistry 41, 309-339.

Watts, B.M., Ylimaki, L.E., Jeffery, L.E. and Elias, L.G. 1989. Basic Sensory Methods for Food Evaluation. IDRC, Canada.