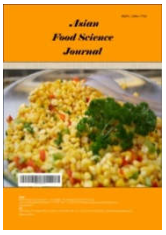

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Physicochemical and Sensory Evaluation of Cookies Produced by Partial Substitution of Margarine with Avocado (*Persia americana*) Pulp

P. A. Adie[1,2*], D. E. Enenche[1,2], T. M. Atsen[2] and C. O. Ikese[1]

[1]Department of Chemistry, Benue State University, Makurdi, Nigeria.
[2]Center for Food Technology and Research, Benue State University, Makurdi, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author PAA designed and coordinated the study, performed the statistical analysis, wrote the protocol and the final draft of the manuscript. Author DEE managed the literature searches and performed the statistical analysis. Author TMA managed the analyses of the study and wrote the draft. Author COI managed the literature searches and the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

The production and determination of the nutritional properties of cookies produced by partial substitution of margarine with avocado pear pulp was studied. Well cleaned avocado pear was blended into paste and used to substitute margarine in the prepared cookies. The ratio of avocado pear pulp substituted was 20%, 30%, 40% and 50%. The substituted products and the control (100% margarine) were subjected to physicochemical and sensory evaluation. The results of the proximate analysis showed that the protein content ranged from 6.93% -7.83% with sample A having the highest protein content and fat content. Moisture content and ash content of samples were seen to be higher in sample E (50:50 ratio). Sample A had the least value of moisture, ash and crude fibre with moisture content of 11.13%, ash content of 1.40% and crude fibre value of 0.29%, while sample E recorded the least value of crude fat (16.00%). The carbohydrate content was recorded to be higher in sample C. The physical properties showed that cookies made with higher avocado pear pulp had less thickness compared to the control cookies. The sensory

**Corresponding author: Email: padie@bsum.edu.ng;*

evaluation results showed that sample A had the highest values of 8.05%, 7.85% and 7.95% for appearance, taste and aroma respectively while sample E (50:50 ratio) had the least values in crunchiness, taste and aroma. The overall acceptability of the results showed that sample A recorded the highest value but not significantly different ($p<0.05$) from sample B (80:20 margarine avocado). The research concluded that the partial substitution of avocado improved the nutritional value of the cookies by lowering the saturated fat content.

Keywords: Cookies; partial substitution; avocado pulp; margarine; sensory evaluation.

1. INTRODUCTION

Cookies are a form of confectionery products dried to low moisture content [1]. Compared to biscuits, cookies tend to be larger with a softer chewier texture [2]. Cookies are consumed extensively all over the world as a snack food and on large scale in developing countries where protein and caloric malnutrition are prevalent [3,4]. With the increased advocacy on the consumption of functional foods by World Nutrition bodies due to health problems such as celiac disease (life-long intolerance to wheat gluten, characterized by inflammation of the proximal small intestine), diabetes and coronary heart disease related to food consumption, the world health organization (WHO) recommends reduction in the overall consumption of sugars and foods that promote high glucose responses [5]. A current trend in nutrition is consumption of low carbohydrate diets, including slowly digestible food products, as well as an increased intake of functional foods [6]. Food processors and industries are thus faced with the challenge of producing food products containing functional ingredients in order to meet the nutritional requirements of individuals with health challenges.

Avocado (*Persia americana*) is an energetic fruit with high nutritional value and is considered a major tropical fruit, since it is rich in protein and contains fat soluble vitamins which are lacking in other fruits, including Vitamins A and B, and median levels of vitamins D and E. It contains different oil levels in the pulp, thus it is widely used in pharmaceutical and cosmetic industries, and for obtaining commercial oils similar to olive oil, because of their similar fatty acid composition [7]. In addition, this fruit has been recognized for its health benefits, especially due to the compounds present in the lipid fraction, such as omega fatty acids, phytosterols, tocopherols, and squalene [8]. It contains a large amounts of heart healthy monounsaturated fats, phytochemicals, dietary fiber and a host of other nutrients beneficial to combating against diseases [9]. Proximate profile shows that avocado pulp contains from 67 to 78% moisture, 13.5 to 24% lipids, 0.8 to 4.8% carbohydrate, 1.0 to 3.0% protein, 0.8 to 1.5% ash, 1.4 to 3.0% fibre, and energy density between 140 and 228kcal [10].

Cookies is one of the commonest snacks, and is prepared using unpalatable dough that is transformed into appetizing products through the application of heat in the oven [11,12]. Its production requires use of margarine, egg, milk, and sugar and wheat flour to mix the dough. Margarine is defined as a plastic product derived from cream, inverted to a water-in-oil emulsion (W/O) with minimum 80% fat. Chemically, a margarine fat consists of a mixture of triglycerides, particularly those derived from fatty acids, such as palmitic, oleic, myristic and stearic acids. Margarine has 61% saturated fats and 33% unsaturated fats. When it is consumed in large quantities for a long period of time, it may have harmful effects on the body including increased cholesterol levels and increased risk of heart disease. Besides increasing the serum lipid levels, margarine has also been reported to increase the level of inflammatory markers which in turn increase the risk of heart diseases [13].

It is therefore incumbent on food scientists to find ways to help reduce the intake of saturated fats in baked foods. Consequently, avocado pear nutritional profile makes it a preferred candidate as a natural fat supplement rich in a variety of health promoting nutrients [13]. It is hoped that the supplementation of margarine with avocado pear pulp will be a promising solution to the challenges posed by complete margarine based products. This work therefore seeks to find an alternative to the consumption of margarine which is rich in saturated fat by substituting with avocado pear pulp. The success of this research therefore will be to eliminate the intake, in cookies, of saturated fat which increases the levels of low-density-lipoprotein (LDL) known to be positively associated with cardiovascular diseases.

2. MATERIALS AND METHODS

2.1 Materials Sourcing

The avocado pear, flour, margarine and other baking ingredients were purchased at Wurukum local market in Makurdi the Benue State capital.

2.2 Avocado Pear Pulp Extraction

The avocado was washed and the pericarp and seed were removed. The pulp was then extracted into a thoroughly washed and dried container and mashed in a blender to obtain smooth paste. The required sample needed for the production was deduced from the paste obtained.

2.3 Cookies Production

The cookies were processed using traditional methods described by [3]. The processing method is given in the flow chart in Fig. 1.

2.4 Analytical Methods

2.4.1 Proximate analysis

This was done to determine nutrient composition of the formulated cookies. The samples were analyzed in triplicates for crude protein, crude fiber, crude fat, moisture, and ash contents using the analytical method described by [14,15].

2.4.2 Physical evaluation of cookies

The weights, thickness and spread ratio were measured before and after baking the cookies, micrometer screw gauge were used to determine the thickness of the cookies and spread ratio were calculated as:

Dt: = (Diameter x thickness).

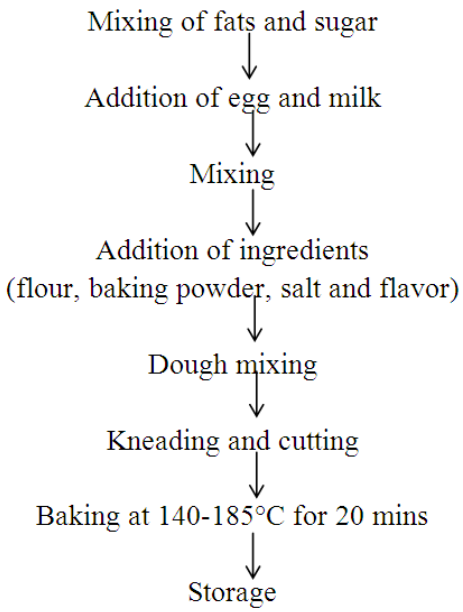

Fig. 1. Flowchart for cookies production

Table 1. Formulation of recipe for analysis

Ingredient (g)	Sample A	Sample B	Sample C	Sample D	Sample E
Wheat Flour	200	200	200	200	200
Margarine	100	80	70	60	50
Mashed avocado pulp	0	20	30	40	50
Sugar	70	70	70	70	70
Vanilla flavor	0.2	0.2	0.2	0.2	0.2
Egg	48.3	48.3	48.3	48.3	48.3
Milk	2	2	2	2	2
Baking powder	2	2	2	2	2
Salt	0.2	0.2	0.2	0.2	0.2

2.4.3 Sensory evaluation

The method described by [11,16] was used for the sensory analysis. Ten semi-trained panelists randomly selected from the staff and students of Benue State University, Makurdi, Nigeria, served as panelists.

All products were put on different coded dishes and served to the panelists. Quality attributes such as appearance, colour, texture, taste, flavour, mouth feel and general acceptability of the products were scored on a 9 point hedonic scale. The degree of likeness was expressed as follows: Like extremely 9, Like very much 8, Like moderately 7, Like slightly 6, Neither like nor dislike 5, Dislike slightly 4, Dislike moderately 3, Dislike very much 2, Dislike extremely 1.

2.5 Statistical Analysis

All experiments were performed in triplicate, and the results are expressed as means ± standard error (SE). Analysis of variance (ANOVA) was used to determine any significant differences in measurements using the SPSS statistical software (SPSS 20.0 for Windows; SPSS Inc., Chicago, IL, USA) at the confidence level of 95%. The significance of the difference between the means was determined using the Duncan's Multiple Range Test, and the differences were considered to be significant at $p< 0.05$ [17].

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Cookies from Partial Substitution of Margarine with Avocado Pear Pulp

Proximate parameters obtained for cookies analysis are presented in Table 2. The moisture content ranged from 11.13 to 14.60%. The cookies made from 50% avocado pear pulp and 50% margarine (sample E) had the highest amount of moisture content (14.60%) while the cookies produced from 100% margarine (sample A) had the least moisture (11.13%). Generally, moisture content increased with substitution of margarine with avocado pear pulp. Judging by the moisture content trend, the shelf life of the cookies would progressively be reduced with substitution of margarine with avocado pear pulp. The protein content varied from 6.93% (60 margarine) to 7.83% (100 margarine). The protein content decreased progressively with substitution of margarine with avocado pear pulp up to Sample D (60 margarine, 40 avocado pear pulp), and then increased in E (50 margarine, 50 avocado pear pulp). Statistically, the variation in protein content with avocado pear pulp substitution was significant ($p < 0.05$) from Sample A up to C and thereafter became non-significant.

Data revealed a steady decrease in crude fat content as margarine was progressively substituted with avocado pear pulp. This crude fat content variation was statistically significant up to Sample C (70 margarine, 30 avocado pear pulp) and then remained statistically non-significant with further avocado pear pulp substitution.

In all the samples there was increase in ash content with substitution of margarine with avocado pear pulp. As seen in Table 2 the variation in ash content with substitution of margarine with avocado pear pulp was statistically significant. The same trend is mirrored in the crude fiber content where there was steady rise in the values as margarine was substituted with avocado pulp. Statistical analysis also corroborates this trend ($p < 0.05$). Carbohydrate content also showed increase in value as the margarine was substituted with the avocado pear pulp, but steeped at Sample E (margarine 50, avocado pulp 50), indicating that the substitution is statistically significant at ($p < 0.05$).

3.2 Physical Properties of Cookies from Partial Substitution of Margarine with Avocado Pear Pulp

Table 3 shows the quantitative physical properties of cookies produced. The values for thickness ranged from 5.02 to 6.02 mm, 4.60 to 5.27 cm for width, 13.92 to 15.89 g for weight and 25.86 to 28.46 for the spread ratio respectively. [1,18] reported similar results for sweet potato cookies to be (4.07 to 6.06 mm, 4.15 to 5.05 cm, 7.25 to 11.55 g, 8.30 to 12) for thickness, width, weight and spread ratio respectively. The weight of the cookies before and after baking showed significant difference ($p < 0.05$), this was due to the lightness of the dough, the avocado margarine cookies thickness was less than wheat dough while rolling into sheet. The spread ratio after baking shows significant difference at ($p < 0.05$) of the cookies sample, indicating that avocado pear pulp promoted swelling of the cookies.

Table 2. Proximate composition of cookies produced by partial substitution of margarine pear pulp (%)

Sample	Moisture	Crude protein	Crude fat	Ash	Crude fiber	Carbohydrate
A	11.13±0.27^{d}	7.83±0.03^{a}	18.03±0.12^{a}	1.40±0.18^{b}	0.29±0.01^{c}	61.31±0.33^{b}
B	11.47±0.24^{cd}	7.43±0.09^{b}	17.00±0.15^{b}	1.72±0.16^{ab}	0.33±0.03^{c}	62.05±0.31^{ab}
C	11.93±0.13^{bc}	6.95±0.13^{c}	16.17±0.09^{c}	1.71±0.15^{ab}	0.45±0.03^{b}	62.79±0.27^{a}
D	12.60±0.20^{b}	6.93±0.07^{c}	16.03±0.09^{c}	1.63±0.20^{ab}	0.54±0.02^{a}	62.26±0.24^{a}
E	14.60±0.21^{a}	7.00±0.06^{c}	16.00±0.06^{c}	2.09±0.10^{a}	0.62±0.02^{a}	59.70±0.16^{c}

Values are mean± standard error

Mean in the same column bearing the same superscript are not significantly different at P < 0.05

Samples

A = 100% margarine (Control)

B = 20% avocado pear pulp and 80% margarine

C = 30% avocado pear pulp and 70% margarine

D = 40% avocado pear pulp and 60% margarine

E = 50% avocado pear pulp and 50% margarine

Table 3. Physical properties of cookies by partial substitution of margarine with avocado pear pulp

Samples	Thickness (mm)	Width (cm)	Weight(g)	Spread ratio
A	5.02 ± 0.01^{a}	5.27±0.15^{c}	14.71±0.03^{d}	26.46± 0.78^{ab}
B	6.01 ± 0.01^{b}	5.03±0.06^{c}	15.89±0.02^{e}	25.86± 1.19^{a}
C	6.02 ± 0.01^{b}	4.30±0.20^{a}	14.25±0.02^{c}	27.86± 1.19^{a}
D	6.02 ± 0.02^{b}	4.60±0.10^{b}	13.97±0.02^{b}	27.25± 0.38^{bc}
E	6.00 ± 0.01^{b}	4.77±0.15^{b}	13.92±0.03^{a}	28.46± 0.93^{cd}

Values are mean± standard error

Mean value with different superscript in the same column are significantly different at (P<0.05)

samples

A = 100% margarine (control)

B = 20% avocado pear pulp and 80% margarine

C = 30% avocado pear pulp and 70% margarine

D = 40% avocado pear pulp and 60% margarine

E = 50% avocado pear pulp and 50% margarine

Table 4. Sensory composition of cookies produced by partial substitution of margarine pear pulp

Sample	Appearance	Texture (ns)	Crunchiness (ns)	Taste (ns)	Aroma (ns)	Overall acceptability
A	8.05±0.20^{a}	7.30±0.31^{a}	6.75±0.34^{a}	7.85±0.23^{a}	7.95±0.18^{a}	7.90±0.16^{a}
B	7.90±0.23^{a}	7.50±0.41^{a}	7.30±0.40^{a}	7.60±0.39^{a}	7.15±0.31^{a}	7.85±0.22^{ab}
C	7.40±0.27^{ab}	7.20±0.41^{ab}	7.10±0.38^{b}	7.50±0.30^{ab}	7.55±0.29^{b}	7.55±0.23^{ab}
D	6.70±0.31^{b}	6.85±0.36^{b}	6.85±0.24^{ab}	6.85±0.33^{ab}	7.00±0.37^{ab}	7.10±0.23^{b}
E	6.95±0.42^{b}	6.90±0.34^{b}	6.65±0.50^{b}	6.65±0.50^{b}	6.95±0.44^{ab}	7.25±0.36^{ab}

Values are mean± standard error

Mean in the same column bearing the same superscript are not significantly different at P < 0.05

Sample

A = 100% margarine (control)

B = 20% avocado pear pulp and 80% margarine

C = 30% avocado pear pulp and 70% margarine

D = 40% avocado pear pulp and 60% margarine

E = 50% avocado pear pulp and 50% margarine

3.3 Sensory Evaluation of Cookies from Partial Substitution of Margarine with Avocado Pear Pulp

The sensory properties of the cookies are presented in Table 4. The score for appearance of the cookies ranged from 6.95 to 8.05. Appearance is a very important parameter in judging properly baked cookies reflecting not only the suitable raw materials used for the preparation but also provides information about the formulation and quality of the product [16,17,19]. As the margarine was progressively substituted with avocado pear pulp the cookies became more and more distasteful to the panelists. Data revealed that substitution was not statistically significant ($p<0.05$) at the beginning, but became significant when 40% of the margarine was substituted.

The score for texture of the cookies ranged from 6.85 to 7.50. The panelist agreed that the texture became more appealing when 10% of the margarine was substituted with avocado pear pulp, but started diminishing as the substitution progressed. This change in texture only became statistically significant ($p<0.05$) when 30% of the margarine was substituted. The crunchiness of the cookies increased with margarine substitution up to 40%, and decreased when 50% of the margarine was substituted. This variation was, however, only statistically significant ($p<0.05$) only when 30% of the margarine had been substituted. Taste and aroma showed a steady decline in values as the margarine was substituted with avocado pear pulp. This decline was only significant statistically ($p<0.05$) when 30% of the margarine was substituted.

The panelists' perception of the general acceptability of the cookies ranged from 7.10 to 7.90 on the hedonic scale. Results showed a slight decrease in general acceptability as the margarine was substituted with avocado pulp. This decrease was statistically significant ($p<0.05$) as the substitution progressed.

4. CONCLUSION

Substitution of margarine with avocado pear pulp produced cookies with improved appearance and general acceptability. Chemical and physical characteristics of cookies made from partial substitution of margarine with avocado pear pulp indicated that avocado pear pulp has the potential to contribute nutritional and physical quality to cookies. It can be used as partial substitute to about 50% without affecting the quality of cookies made from it. The cookies produced in this study generally had higher ash and moisture while sensory attributes were comparable to traditionally accepted products.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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