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Peanut biscuit ready mix as a nutrient dense food
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Peanuts apart from being an important oil seed crop have also gained prominence as popular snacks and confectionaries in the US and around the world. The health benefits of peanuts have been well documented in many ancient cultures and are widely studied by the modern researchers. Currently, there are strong interests on utilizing peanut meal or press cake. In order to explore more ways to incorporate the peanut flour into the products of daily use, this study was designed to study the feasibility of incorporating peanut flour into biscuits. Biscuits are well known breakfast options here in the United States and especially in the southern US. Incorporating peanut flour into the biscuits would increase the protein content and overall nutritional quality of biscuits.

Several different biscuit formulations containing self-rising flour, peanut flour, baking soda, baking powder, milk, buttermilk and in different amount were evaluated. The formulation containing 125 g all-purpose wheat flour, 18 g shortening, 1/3 cup butter milk powder, 1/2 teaspoon, 1/4 teaspoon baking soda and 1/4 cup of water produced the best quality biscuits and was selected as base formula for peanut biscuit development studies. Two different peanut flours, 12% fat (light and dark roasted) and 28% fat (both light and dark roasted) were used for the study. Effect of different amount (10 to 40%) of peanut flour replacement, addition of egg powder, and yeast were then studied. Biscuits made with egg powder and 10% peanut flour replacement were easy to open and with flaky texture. Increased the peanut flour replacement to 20%, biscuits became darker and had less flaky texture than the 10% peanut flour replacement. Further increased to 30% replacement, peanut biscuits were dark and not flaky. Biscuits made with 40% peanut flour replacement had very dark color and top surface became very crumbly. None of the biscuits made with yeast and peanut flour replacement had flaky texture. Biscuits made with both baking powder and baking soda were all easy to open and with porous structure.

Gummy texture of the peanut flour biscuits is due to the high protein content of the peanut flour. Fermentation is known to add more nutritional benefits to the products and has the benefit of breaking down the protein and increasing the free soluble phenolic content. Peanut flour was fermented with buttermilk for either 30 min or 6 hr. and fermented peanut flour was added to the mixture of all-purpose flour with leavening agents, shortening and salt. The mixture was lightly mixed in then rolled out and cut into biscuits and baked. The rise of biscuit made from fermented peanut flour was good when compared to the non-fermented formulations. Along with good rise, the texture of the peanut flour biscuit was also less gummy and more porous than biscuit made with the non-fermented peanut flour.

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Final REPORT:

Peanuts apart from being an important oil seed crop have gained prominence as popular snacks and confectionaries in the US and around the world. The health benefits of peanuts have been well documented in many ancient cultures and are widely studied by the modern researchers. Currently, there are strong interests on utilizing peanut meal or press cake. Many research studies have explored the ways to utilize the protein rich peanut flour. For example, making value added products like peanut flour pasta, akara and chips etc. Still the peanut meal or defatted peanut flour seems an alluring option for the food innovation because of its nutrient dense nature.

In order to explore more ways to incorporate the peanut flour into the products of daily use, this study is investigating the possibility of incorporating peanut flour into biscuits. Biscuits are well known breakfast options here in the United States and especially in the southern US. Incorporating peanut flour into the biscuits would increase the protein content and overall nutritional quality of biscuits. Traditionally, biscuits are made using bleached flour or all-purpose flour which has a very little protein content. This leaves a good scope for developing formulations by substituting a suitable amount of peanut flour in the biscuits. The objectives of this project were: (1) Evaluate the feasibility of partially replacing wheat flour with peanut flour in a basic biscuit formulation, (2) optimize product formula for maximum nutrient fortification, and (3) characterize the physiochemical properties of the finished product.

All-purpose flour is usually used for making biscuits because gluten, the protein in wheat flour forms structural networks which contributed to the flaky texture of biscuits. This is one of the big challenges in substituting the all-purpose wheat flour with the peanut flour. The protein rich peanut flour also would readily form protein networks; however, this may not let the biscuits rise during baking and formed a flaky texture. Several recipes and formulations of biscuit were evaluated to identify a quality reference control.

The first set of formulation evaluated is list as follow. The abbreviations used are: SRF for self-rising flour, PNF for peanut flour, BS for baking soda, BP for baking powder, Tsp for teaspoon, and Tbsp for table spoon.

Table 1. Biscuit receipt #1.

	With shorting	With oil
SRF	1 cup	1 cup
FAT	¼ cup (shortening)	½ cup oil
Buttermilk	0	0
Buttermilk powder	1/2 table spoons	1/2 table spoons
BS	½ tsp	½ tsp
BP	¼ tsp	¼ tsp
Water	< 1/2 cup	< 1/2 cup

Biscuits made from the formulation with shorting were soft but had good rising whereas formulation with oil were very hard with no rise.

Another set of formulation from www.cooks.com was also selected for evaluation.

Table 2. Biscuit receipt #2.

	With milk	With butter milk
SRF	1 cup	1 cup
FAT	5 Tbsp butter	5 Tbsp butter
Milk	2/3 cup	
Buttermilk		2/3 cup
BP	2 tsp	2 tsp
Salt	½ tsp	½ tsp

Biscuits made from the formulation with milk only had medium rise and with soft and not very flaky texture. Biscuits made from formulation with butter milk were also soft and not very flaky plus medium rise. To evaluate low temperature setting on the property of biscuit dough made with butter milk, dough mixture were prepared and refrigerated overnight. Flakier biscuits were produced than the formulation without overnight refrigeration.

Table 3. Effect of dough temperature on biscuit quality.

	10% replacement of medium roast 12% fat peanut flour	10% replacement of light roast 28% fat peanut flour	33% replacement of medium roast 12% fat peanut flour	25% replacement of medium roast 12% fat peanut flour
SRF	112.5 g	112.5 g	83.75 g	93.75 g
PNF	12.5 g	12.5 g	41.25 g	31.25 g

FAT	5 Tbsp shortening	5 Tbsp shortening	5 Tbsp shortening	5 Tbsp shortening
Buttermilk pwdr	2 Tbsp	2 Tbsp	2 Tbsp	2 Tbsp
BS				½ tsp
BP	1 tsp	1 tsp	1 tsp	1 tsp
Water	¼ cup	¼ cup	¼ cup	¼ cup
Salt	½ tsp	½ tsp	½ tsp	½ tsp

Regardless of type of peanut flour used (12% fat medium roast or 28% fat light roast), biscuits with flaky texture can be obtained. When peanut flour replacement increased to 25%, biscuits were only slightly flaky. Further increased peanut flour replacements to 33%, biscuits produced were very dense with only medium raise.

A commercial biscuit mix was used and 25% of which was replaced with 12% medium peanut flour. The biscuits prepared were very flaky and light. Based on the information collected from different biscuit formulation study, the following formulation was selected as the starting formulation for peanut biscuit development.

Table4. Base formulation for peanut flour substitution study.

	Amount
All-purpose wheat flour	125 g
Shortening	18 g
Butter milk powder	1/3 cup
Baking powder	1/2 tsp
Water	1/4 cup
Baking soda	1/4 tsp

Peanut flour (12% fat and medium roast) was then used to substitute 10, 20, 30, and 40% of the all-purpose wheat flour in the above mentioned recipe. Amount of shorting used in the recipe was adjusted to 16.8, 15.6, 14.4, and 13.2 g to make up for the additional fat from peanut flour. Initially Buttermilk was used in the recipe for flavor and texture, later buttermilk powder was used instead for converting the formulation to dry mix. Both buttermilk and buttermilk powder only added to the flavor but showed no positive effect on the rise.

Table 5. Effect of fat content on biscuit.

	10 % PNF	20% PNF	30 % PNF	40% PNF
SRF	112.5 g	100 g	87.5 g	100 g
PNF	12.5 g	25 g	37.5 g	50 g
FAT	16.8 g shortening	15.6 g shortening	14.4 g shortening	13.2 g shortening
Egg powder	3 g	3 g	3 g	3 g
Buttermilk pwdr	2Tbsp	2Tbsp	2Tbsp	2Tbsp

BP	½ tsp	½ tsp	½ tsp	½ tsp
Water	¼ cup	¼ cup	¼ cup	¼ cup
BS	1/4 tsp	1/4 tsp	1/4 tsp	1/4 tsp

Biscuits made with egg powder and 10% peanut flour replacement were easy to open and with flaky texture. Increased the peanut flour replacement to 20%, biscuits became darker and had less flaky texture than the control and with 10% peanut flour replacement. Further increased to 30% replacement, peanut biscuits were dark and not flaky. Biscuits made with 40% peanut flour replacement had very dark color and top surface very crumbly.

Table 6. Formulation with yeast

	10 % PNF	20% PNF	30 % PNF	40% PNF
SRF	112.5 g	100 g	87.5 g	100 g
PNF	12.5 g	25 g	37.5 g	50 g
FAT	16.8 g shortening	15.6 g shortening	14.4 g shortening	13.2 g shortening
Yeast	1 tsp	1 tsp	1 tsp	1 tsp
Buttermilk powdr	2Tbsp	2Tbsp	2Tbsp	2Tbsp
BP	½ tsp	½ tsp	½ tsp	½ tsp
Water	¼ cup	¼ cup	¼ cup	¼ cup
BS	1/4 tsp	1/4 tsp	1/4 tsp	1/4 tsp

None of the biscuits made with yeast and peanut flour replacement had flaky texture and difficult to open except at 10% replacement level.

Table 7. Formulation with baking soda

	10 % PNF	20% PNF	30 % PNF	40% PNF
SRF	112.5 g	100 g	87.5 g	100 g
PNF	12.5 g	25 g	37.5 g	50 g
FAT	16.8 g shortening	15.6 g shortening	14.4 g shortening	13.2 g shortening
Buttermilk	1/3 cup	1/3 cup	1/3 cup	1/3 cup
Water	¼ cup	¼ cup	¼ cup	¼ cup
BS	1/4 tsp	1/4 tsp	1/4 tsp	1/4 tsp

Biscuits made with baking soda were all easy to open and with porous structure. Biscuits made with 40% peanut flour replacement had less raise than from low levels of peanut flour replacement.

Table 8. Formulation with both baking powder and baking soda

	10 % PNF	20% PNF	30 % PNF	40% PNF
SRF	112.5 g	100 g	87.5 g	100 g
PNF	12.5 g	25 g	37.5 g	50 g
FAT	16.8 g shortening	15.6 g shortening	14.4 g shortening	13.2 g shortening
Buttermilk	1/3 cup	1/3 cup	1/3 cup	1/3 cup
BP	½ tsp	½ tsp	½ tsp	½ tsp
Water	¼ cup	¼ cup	¼ cup	¼ cup
BS	1/4 tsp	1/4 tsp	1/4 tsp	1/4 tsp

Biscuits made with both baking powder and baking soda were all easy to open and with porous structure. Biscuits made with 40% peanut flour replacement had less raise than from low levels of peanut flour replacement. In general, these biscuits were more porous structure than the one made with baking soda alone.

In general, leavening agents were found had no significant effect on the biscuit quality. Egg powder and yeast were also tried to see if these ingredients can enhance the texture of the biscuits. None of the above had any positive effect on the peanut biscuit texture when peanut flour replacement increased to 30% or above.

Understanding that the gummy texture of the peanut flour biscuits is due to the protein content of the peanut flour, fermentation of the peanut flour was done in order to denature the proteins and stop them from forming the networks. Fermentation is known to add more nutritional benefits to the products for example easy digestion, enhancing the flavor etc. Further, it has also been shown that fermentation of legumes increases the free soluble phenolic content and enhanced the antioxidant activity. Hence, biscuits with fermented peanut flour would not only help in developing tasty breakfast option without sacrificing the taste and texture but they would also be a good source for delivering quality protein, vitamins, minerals and antioxidants for better health.

Peanut flour was fermented with buttermilk for either 30 min or 6 hr. and fermented peanut flour was added to the mixture of all-purpose flour with leavening agents, shortening and salt. The mixture was lightly mixed in then rolled out and cut into biscuits and baked. The rise of biscuit made from fermented peanut flour was good when compared to the non-fermented formulations. Along with good rise, the texture of the peanut flour biscuit was also less gummy and more porous.

Three way mixed ANOVA program from the SAS 9.3 was used for the data analysis. Results in Table 9 suggested that 30 min fermentation was sufficient to increase the total volume of biscuit. Fat content has no significant effect on biscuit volume while biscuit made with dark roasted peanut flour had lower volume. This may be due to the dark roasted peanut flour has higher degree of protein denaturation. Biscuits made with dark roasted peanut flour had higher density than light roasted peanut flour for 12% fat peanut flour. However, biscuits made with dark roasted peanut flour had lower density than light roasted peanut flour for 28% fat peanut flour. For dark roasted peanut, peanut biscuits made with 28% fat were less dense than biscuits made with 12% fat.

Table 9. Effect of fermentation on the density and volume of biscuit.

Biscuit Volume (ml)	Fermentation time (hr)	12% fat		28% fat	
		Light roasted	Dark roasted	Light roasted	Dark roasted
Peanut flour substitution (%)					
10	0.5	101	96	111	101
25	0.5	103	103	103	106
40	0.5	115	106	101	101
10	6	118	95	114	102
25	6	113	103	117	97
40	6	110	102	115	89
Bulk density (g/ml)					
10	0.5	0.558	0.633	0.531	0.478
25	0.5	0.535	0.637	0.590	0.471
40	0.5	0.509	0.554	0.605	0.49
10	6	0.496	0.629	0.490	0.490
25	6	0.496	0.546	0.492	0.530
40	6	0.543	0.533	0.517	0.569

The color parameters Hue angle represents the color on a hue circle. Hue angle of 0 represent the Red color and 90 represent the yellow. For a hue angle of 45 represent brown color. For the peanut biscuit, hue angle ranged from 51 to 80 and the lower the hue angle ready the browner the color. In general, biscuit made with dark roasted or high fat (28%) peanut flour had darker brown color than biscuit made with light roasted or low fat (12%) peanut flour. The higher the percentage of peanut flour substitution, the darker the brown color.

Table 10. Effect of fermentation on the color of biscuit.

Hue Angle	Fermentation time (hr)	12% fat		28% fat	
		Light roasted	Dark roasted	Light roasted	Dark roasted
Peanut flour substitution (%)					
10	0.5	74.52	72.32	74.75	61.99
25	0.5	71.17	68.63	66.42	53.80
40	0.5	70.77	64.01	64.97	50.85
10	6	79.06	72.48	74.15	62.42
25	6	75.14	68.59	71.05	55.86
40	6	69.56	64.35	66.68	53.10
Chroma					
10	0.5	30.31	31.69	27.89	18.19
25	0.5	32.88	29.50	30.46	15.94

40	0.5	32.06	26.63	27.71	12.96
10	6	28.99	29.58	30.38	16.36
25	6	27.81	29.09	28.37	15.71
40	6	28.03	26.55	27.66	14.66