



ISSN (E): 2277- 7695  
ISSN (P): 2349-8242  
NAAS Rating 2017: 5.03  
TPI 2017; 6(11): 822-826  
© 2017 TPI  
www.thepharmajournal.com  
Received: 24-09-2017  
Accepted: 25-10-2017

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## Studies on shelf life of developed extruded (Noodles and Macroni) and baked (Rusk and Cookies) products incorporated with okara (Soybean milk byproduct) powders

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### Abstract

The study was conducted to evaluate the shelf life of developed extruded (noodles and macroni) and baked (rusk and cookies) products incorporated with okara (soyabean milk byproduct) powder. The developed extruded noodles (incorporated with 30 percent freeze dried okara powder) and macroni (incorporated with 20 percent freeze dried okara powder), and baked rusks (incorporated with 20 percent freeze dried okara powder) and cookies (incorporated with 20 percent solar tunnel dried okara powder) including their control (prepared with refined flour) were stored at room temperature ( $28 \pm 2$  °C) for 3 months and were studied for sensory quality, fat acidity and TBARS values at a regular interval of 15 days. It was observed that the mean scores for overall sensory parameters of developed products decreased as the storage period increased. Fat acidity and peroxide values increased in control and supplemented cookies and rusks as the storage period increased. However, the rusks were acceptable up to 45 days with more than 6 (liked slightly) overall acceptability scores but noodles, macroni and cookies were acceptable up to 30 days of storage with around 7 (liked moderately) sensory score.

**Keywords:** Okara, noodles, macroni, rusks, cookies

### Introduction

Okara has high protein content (40% on a dry weight basis) with good essential amino acid profile and *in vitro* digestibility<sup>[1]</sup>. The fat that remains in okara is approximately 10%, with high polyunsaturated fatty acid content. Small amounts of starch, sugars and significant levels of B group vitamins and potassium are also recovered in okara<sup>[2]</sup>. Despite the high nutritional and excellent functional properties like protein solubility, water holding capacity, emulsification, foaming, and binding properties of okara makes it suitable for potential application in food products, the most common use of this by-product is in the manufacture of animal feed<sup>[3]</sup>. Okara also contains high amounts of dietary fiber and is considered as an excellent dietary fibre source and as such could be added to different foods.

Furthermore, okara contains isoflavonoids which have a positive effect on health like lowering of certain hormone-dependent cancers, cardiovascular diseases and osteoporosis, possibly due to their antioxidative properties and their ability to bind the oestrogen receptor<sup>[4]</sup>. Approximately one-third of the isoflavones present in the soybean remains in okara, suggesting that it is a good, low cost source of nutrients<sup>[5, 6]</sup>.

*In vitro* experiments have indicated that okara is a potential source of antioxidant components<sup>[7]</sup>, showing that protease hydrolysate from okara yielded antioxidant activity<sup>[8]</sup>. Since okara is a cheap and rich source of good quality protein and dietary fiber, many Asian countries have found a variety of ways to make use of okara in many food items such as soups, salads, baked goods and fermented food products<sup>[4, 9]</sup>. Studies have been conducted on development of extruded (noodles and macroni) and baked (rusk and cookies) products incorporated with okara (soyabean milk byproduct) powders but the information is still lacking on shelf life of these value added products based on okara.

### Material and Methods

#### Extruded Products

Two types of developed extruded products viz., noodles with 30 percent freeze dried okara powder (T<sub>1</sub>) and macroni with 20 percent freeze dried okara powder (T<sub>2</sub>) were prepared. In control 100 percent refined wheat flour was used.

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## Extruding of noodles/ macroni

Ingredients	Control	T <sub>1</sub>	T <sub>2</sub>
Refined wheat flour	100g	70g	80g
Okara powder	---	30g	20g
Oil	5 ml	5 ml	5 ml
Water	15ml	15ml	15ml

- Sieved the refined wheat flour
- Added oil and rubbed the flour between fingers and palms
- Added water slowly and kneaded the flour tightly
- Made a stiff dough
- Run dough through machine
- Products extruded from the machine were collected on trays and dried overnight

## Cooking of noodles/ macroni

Ingredients	Noodles	Macroni
Noodles	100 g	100 g
Capsicum	30g	30g
Onion	25g	25g
Cabbage	30g	-
Tomato	-	30g
Green chilli sauce	1 tsp	-
red chilli powder	-	¼tsp
Soy sauce	1 tsp	-
Tomato sauce	1 tsp	1 tsp
Black pepper	1 pinch	1 pinch
Salt	To taste	To taste
Vegetable oil	25ml	25ml

- Boiled noodles with one tea spoon of vegetable oil and strained.
- Washed vegetables (onion, cabbage, capsicum and green chilli) and cut length wise
- Heated oil in pan, added onion and fried till golden brown
- Added capsicum and cabbage and fried for 5 minutes.
- Added green chilli sauce, tomato sauce, soya sauce and stirred for 2 minutes.
- Added salt and black pepper and stirred for 2 minutes
- Added boiled noodles and stirred continuously for 2 minutes.
- Plated and served

## Baked products

Two types of baked products viz., rusk with 20 percent freeze dried okara powder (T<sub>3</sub>) and cookies with 20 percent solar tunnel dried okara powder (T<sub>4</sub>) were prepared. In control 100 percent refined wheat flour was used.

## Baking of Rusks/cookies

Ingredients	Control Rusks	Developed Rusks	Control Cookies	Developed Cookies
Refined flour	100g	80g	100	80g
Okara powder	-----	20g	-----	20g
Eggs	2nos.	2nos.	----	--
Butter	100g	100g	110g	110g
Powdered sugar	30g	30g	-----	---
Icing sugar	-	-	40g	40g
Milk	30ml	30ml	---	-
Custard powder	-	-	20g	20g
Baking powder	¾tsp	¾tsp	¾tsp	¾tsp
Vanilla essence	2-3 drops	2-3 drops	3-4 drops	3-4 drops

## Processing of Rusks

- Preheatd oven to 180°C.
- Greased the tin having edge 8cm.
- Sifted flour and baking powder and kept aside
- In a bowl creamed butter and sugar then mixed eggs followed by vanilla and beated.
- Added flour mixture and mixed well by cut and fold technique.
- Poured batter into prepared tin and baked for 40-45 minutes.
- Cut the cake into 2cm thick slice and baked it for 20-25 minutes at 120-130 °c.

## Processing of Cookies

- Pre heated oven at 180°C
- Mixed refined flour, baking powder and custard powder.
- Creamed butter and sugar and beat till fluffy then added vanilla.
- Sifted the flour mixture and beat slowly with electric beater.
- Kneaded the flour and wrapped it in thin plastic film by rolling it in tubes.
- Kept in refrigerator for 15-20 minutes.
- Cut into 1cm thick slice with cookies cutter
- Placed on greased trays and baked for 20-25 minutes.

All the control and developed products were stored in air tight containers upto 45 days at ambient temperature and evaluated for their shelf life on the basis of sensory, fat acidity and peroxide value.

**Results and Discussion**

**Sensory evaluation**

The supplemented noodles were liked very much by the panelists on 0 day and the mean scores given by the panelists for the attributes overall acceptability were 7.94 (Table 1). However, no such remarkable difference was observed on 15<sup>th</sup> day of storage. On 30<sup>th</sup> day mean scores for aroma and taste decreased significantly and were “liked slightly”, whereas further storage i.e upto 45<sup>th</sup> day all the sensory scores declined to “neither liked and nor disliked”. Work has also been reported that incorporation of 20 percent okara in noodles increased its storability, without any significant change in colour and flavour [10].

**Table 1:** Effect of storage (28±2 °C) period on sensory evaluation of developed extruded and baked products. N=18

Products	Storage period			
	0	15	30	45
<b>Colour</b>				
Noodles	7.90 <sup>B</sup> ± 0.21	7.60 <sup>B</sup> ± 0.10	6.95 <sup>AB</sup> ± 0.25	6.30 <sup>A</sup> ± 0.13
Macroni	7.75 <sup>A</sup> ± 0.20	7.55 <sup>A</sup> ± 0.28	7.40 <sup>A</sup> ± 0.18	7.05 <sup>A</sup> ± 0.20
Rusks	7.75 <sup>A</sup> ± 0.27	7.70 <sup>A</sup> ± 0.13	7.65 <sup>A</sup> ± 0.18	7.55 <sup>A</sup> ± 0.20
Cookies	7.25 <sup>A</sup> ± 0.27	7.10 <sup>A</sup> ± 0.21	6.95 <sup>A</sup> ± 0.17	6.85 <sup>A</sup> ± 0.21
<b>Appearance</b>				
Noodles	7.95 <sup>C</sup> ±0.18	7.55 <sup>C</sup> ±0.13	6.57 <sup>B</sup> ±0.21	5.70 <sup>A</sup> ±0.17
Macroni	7.70 <sup>B</sup> ±0.18	7.15 <sup>B</sup> ±0.26	6.20 <sup>A</sup> ±0.19	5.75 <sup>A</sup> ±0.20
Rusks	7.77 <sup>B</sup> ±0.13	7.45 <sup>AB</sup> ±0.26	7.05 <sup>AB</sup> ±0.09	6.75 <sup>A</sup> ±0.20
Cookies	7.50 <sup>A</sup> ±0.13	7.40 <sup>A</sup> ±0.20	7.05 <sup>A</sup> ±0.14	6.95 <sup>A</sup> ±0.11
<b>Aroma</b>				
Noodles	7.80 <sup>C</sup> ±0.23	7.45 <sup>C</sup> ±0.29	6.35 <sup>B</sup> ±0.19	5.00 <sup>A</sup> ±0.23
Macroni	7.87 <sup>D</sup> ±0.21	7.20 <sup>C</sup> ±0.18	6.15 <sup>B</sup> ±0.15	5.25 <sup>A</sup> ±0.23
Rusks	7.55 <sup>B</sup> ±0.21	7.20 <sup>B</sup> ±0.18	6.70 <sup>B</sup> ±0.15	5.55 <sup>A</sup> ±0.13
Cookies	7.15 <sup>C</sup> ±0.21	6.95 <sup>BC</sup> ±0.17	6.60 <sup>B</sup> ±0.21	5.75 <sup>A</sup> ±0.26
<b>Texture</b>				
Noodles	7.93 <sup>C</sup> ±0.18	7.75 <sup>C</sup> ±0.17	6.80 <sup>B</sup> ±0.14	5.05 <sup>A</sup> ±0.19
Macroni	7.85 <sup>C</sup> ±0.22	7.15 <sup>C</sup> ±0.20	6.25 <sup>B</sup> ±0.13	5.25 <sup>A</sup> ±0.20
Rusks	7.68 <sup>C</sup> ±0.23	7.15 <sup>BC</sup> ±0.27	6.55 <sup>B</sup> ±0.18	5.45 <sup>A</sup> ±0.20
Cookies	7.25 <sup>C</sup> ±0.23	6.70 <sup>B</sup> ±0.20	6.55 <sup>B</sup> ±0.13	5.90 <sup>A</sup> ±0.20
<b>Taste</b>				
Noodles	7.95 <sup>D</sup> ±0.20	7.05 <sup>C</sup> ±0.15	6.30 <sup>B</sup> ±0.15	5.41 <sup>A</sup> ±0.19
Macroni	7.72 <sup>B</sup> ±0.20	7.15 <sup>B</sup> ±0.21	6.10 <sup>A</sup> ±0.19	5.50 <sup>A</sup> ±0.19
Rusks	7.70 <sup>B</sup> ±0.20	7.15 <sup>B</sup> ±0.21	6.50 <sup>B</sup> ±0.19	5.00 <sup>A</sup> ±0.19
Cookies	7.35 <sup>C</sup> ±0.20	6.75 <sup>BC</sup> ±0.16	6.40 <sup>B</sup> ±0.20	5.15 <sup>A</sup> ±0.19
<b>Overall acceptability</b>				
Noodles	7.94 <sup>D</sup> ±0.19	7.24 <sup>C</sup> ±0.27	6.61 <sup>B</sup> ±0.14	5.35 <sup>A</sup> ±0.13
Macroni	7.77 <sup>C</sup> ±0.16	7.15 <sup>BC</sup> ±0.14	6.45 <sup>B</sup> ±0.29	5.45 <sup>A</sup> ±0.18
Rusks	7.67 <sup>C</sup> ±0.13	7.35 <sup>C</sup> ±0.24	6.85 <sup>B</sup> ±0.29	6.10 <sup>A</sup> ±0.18
Cookies	7.30 <sup>C</sup> ±0.13	6.60 <sup>B</sup> ±0.28	6.50 <sup>B</sup> ±0.10	5.75 <sup>A</sup> ±0.18

Means ± SD with different superscripts row wise differ significantly (p≤0.05).

There was no significant change in colour of the macroni throughout storage period. Up to 15 days, all the sensory characteristics of macroni were ‘liked moderately’, except colour which was ‘liked very much’. On 30<sup>th</sup> day of storage a significant reduction in the mean scores for overall acceptability of macroni was observed and was liked slightly by the judges. On 45<sup>th</sup> day of storage period the mean scores for aroma, texture, taste and overall acceptability decreased significantly and was ‘neither liked nor disliked’ by the judges.

The mean scores of fresh rusks for colour, appearance, aroma, texture, taste and overall acceptability were highly acceptable and the colour of the rusks did not change throughout storage period. Stored rusks on 15<sup>th</sup> day were liked moderately by the judges in all the sensory attributes. With the advancement of storage period (on 30<sup>th</sup> day) a significant change in the mean scores of aroma, texture, taste and overall acceptability was observed. On 45<sup>th</sup> day, sensory scores for aroma and overall acceptability were ‘liked slightly’ and the product was acceptable. Sengupta *et al.* [11] reported that apart from physico- chemical property, okara dried by vacuum tray drying gives better results for sensory evaluation in respect of colour, flavour and all over acceptance and it is safe for health due to retention of nutrients.

It was observed that there were no significant changes in the mean scores of colour and appearance from 0 to 45 days of storage period in supplemented cookies. However, mean scores for taste of cookies reduced significantly on 30<sup>th</sup> day of storage period. On 45<sup>th</sup> day mean scores for sensory parameter for taste was ‘neither liked nor disliked’ by the judges. Okara koji substitution upto 10 percent in soft flour for preparation of cookies significantly suppressed the oxidation of lipid in cookies without any effect on their textural properties and palatability [12].

**Fat acidity**

The data on fat acidity content of control as well as most acceptable supplemented products are presented in Table 2. On zero day of storage, fat acidity content of control was significantly lower than supplemented noodles. Control noodles had 38.21 mg KOH/100g on zero days which increased significantly with the increase in storage period and reached 50.24 mg KOH/100g at 45 days of storage. Similar trend was also observed in supplemented noodles which had fat acidity 40.54 mg KOH/100g on zero day of storage and as the storage period increased the fat acidity content up to 60.33 mg KOH/100g on 45<sup>th</sup> day. The increase in fat acidity could be attributed to hydrolysis of triglycerides resulting in the formation of free fatty acids with increase in storage period.

**Table 2:** Effect of storage (28±2 °C) period on fat acidity (mg KOH/100g) content of extruded and baked products (on dry matter basis). N=6

Products	Storage period			
	0 Days	15 Days	30 Days	45 Days
<b>Extruded products</b>				
Control Noodles	38.21 <sup>aA</sup> ±0.57	40.38 <sup>bA</sup> ±0.23	45.66 <sup>cA</sup> ±0.18	50.24 <sup>dA</sup> ±0.42
Developed Noodles	40.54 <sup>aB</sup> ±0.31	45.62 <sup>bB</sup> ±0.12	50.76 <sup>cB</sup> ±0.23	60.33 <sup>dB</sup> ±0.30
Control Macroni	38.04 <sup>aA</sup> ±0.66	40.30 <sup>bA</sup> ±0.24	44.82 <sup>cA</sup> ±0.36	49.03 <sup>dA</sup> ±0.14
Developed Macroni	40.24 <sup>aB</sup> ±0.32	44.68 <sup>bB</sup> ±0.03	49.41 <sup>cB</sup> ±0.21	58.26 <sup>dB</sup> ±0.63
<b>Baked products</b>				
Control Rusks	49.20 <sup>aA</sup> ±0.27	53.31 <sup>bB</sup> ±0.57	57.27 <sup>cBC</sup> ±0.62	62.50 <sup>dB</sup> ±0.35
Developed rusks	51.05 <sup>aB</sup> ±0.21	55.83 <sup>bC</sup> ±0.66	58.13 <sup>cC</sup> ±1.34	64.24 <sup>dC</sup> ±0.15
Control cookies	48.34 <sup>aA</sup> ±0.02	50.20 <sup>bA</sup> ±0.16	54.41 <sup>cA</sup> ±0.26	59.34 <sup>dA</sup> ±0.06
Developed cookies	49.20 <sup>aB</sup> ±0.12	51.82 <sup>bB</sup> ±0.02	56.56 <sup>cB</sup> ±0.23	61.40 <sup>dB</sup> ±0.32

Means ± SD with different small letters row wise and capital letters column wise superscripts differ significantly (p≤0.05) in different products.

Macroni had 40.24 mg KOH/100g on zero day which was significantly higher than the fat acidity content of control macroni (38.04 mg KOH/100g) on zero day. Similar trend was observed in 30 and 45 days of storage in both the products i.e. control as well as of macroni which had 49.03 and 58.26 mg KOH/100g (on 45<sup>th</sup> day).

Control and developed rusks exhibited 49.20 and 51.05 mg KOH/100g, fat acidity, respectively, on zero day which differed significantly with each other, similarly on 15<sup>th</sup> day of storage was observed. However, on 30<sup>th</sup> day of storage a non significant difference in the fat acidity content of both control (57.27 mg KOH/100g) as well as of developed rusks (58.13 mg KOH/100g) were observed. On 45<sup>th</sup> day of storage significant increase in fat acidity content of developed rusks (62.50 mg KOH/100g) as compared to the control rusks (64.24 mg KOH/100g) was noticed. Ahlawat and Jood (2011) reported that the increase in fat acidity could be attributed to hydrolysis of triglycerides resulting in the formation of free fatty acids with increase in storage period [13].

Fat acidity content of control showed significant lower values than cookies from zero day to the end of storage period. It was noticed that as the storage period increased, fat acidity content also increased in control and cookies.

### Peroxide value

The data on peroxide value of control and developed products are presented in Table 3. The significant differences in peroxide value of control as well as of noodles were noticed after every fifteen days of storage period. However developed noodles showed slightly higher peroxide values as compared to the control noodles on the respective periods of storage.

Similar increasing trend in peroxide value was observed in developed macroni which had 2.92, 2.65 and 4.28 meq/100g peroxide value, respectively, on 15, 30 and 45 days of storage. The developed macroni had significantly higher peroxide value as compared to control macroni.

Significant increment in peroxide value of developed rusks was also observed from 0 to 45 days of storage.

**Table 3:** Effect of storage (28±2 °C) period on peroxide value (meq/100g) of extruded and baked products (on dry matter basis). N=6

Products	Storage period			
	0 Days	15 Days	30 Days	45 Days
<b>Extruded</b>				
Control Noodles	2.31 <sup>aA</sup> ±0.11	2.87 <sup>bB</sup> ±0.10	3.31 <sup>cB</sup> ±0.08	3.98 <sup>dB</sup> ±0.03
Developed Noodles	2.54 <sup>aB</sup> ±0.13	3.20 <sup>bC</sup> ±0.13	3.83 <sup>cD</sup> ±0.23	4.42 <sup>dD</sup> ±0.06
Control macroni	2.30 <sup>aA</sup> ±0.27	2.68 <sup>bA</sup> ±0.12	2.98 <sup>cA</sup> ±0.19	3.42 <sup>dA</sup> ±0.12
Developed macroni	2.57 <sup>aB</sup> ±0.33	2.92 <sup>bB</sup> ±0.25	3.65 <sup>cC</sup> ±0.13	4.28 <sup>dC</sup> ±0.07
<b>Baked</b>				
Control rusks	2.45 <sup>aA</sup> ±0.20	3.25 <sup>bC</sup> ±0.14	3.97 <sup>cB</sup> ±0.11	4.56 <sup>dA</sup> ±0.05
Developed rusks	2.61 <sup>aD</sup> ±0.26	3.68 <sup>bD</sup> ±0.25	4.50 <sup>cC</sup> ±0.14	4.94 <sup>dC</sup> ±0.16
Control cookies	2.58 <sup>aB</sup> ±0.02	2.83 <sup>bA</sup> ±0.01	3.69 <sup>cA</sup> ±0.01	4.52 <sup>dA</sup> ±0.02
Developed cookies	2.65 <sup>aC</sup> ±0.03	2.93 <sup>aB</sup> ±0.03	2.74 <sup>aA</sup> ±0.02	4.76 <sup>bB</sup> ±0.03

Means ± SD with different small letters row wise and capital letters column wise superscripts differ significantly ( $p \leq 0.05$ ) in different products.

Control cookies had 2.58 meq/100g peroxide value on 0 day of storage which increased significantly on increasing the storage period. It was noticed that on 45<sup>th</sup> day the peroxide values of all the control products increased. Similar trend in supplemented products was evidenced, except cookies in which no increment in peroxide values on 30<sup>th</sup> day was observed. The increase might be due to the oxidation of polyunsaturated fatty acids which lead to the rancidity and off flavour development [13].

### Conclusion

It is concluded that the mean scores for overall sensory parameters of developed products decreased as the storage period increased. Fat acidity and peroxide values increased in control and supplemented cookies and rusks as the storage period increased. However, the rusks were acceptable up to 45 days with more than 6 (liked slightly) overall acceptability scores but noodles, macroni and cookies were acceptable up to 30 days of storage with around 7 (liked moderately) sensory score.

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