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# Utilization of Soy Okara in preparation of Nutraceutical Buns for Food Security

*Pankuku & Singh*

## Abstract

Soy okara, a by-product of soy milk processing, is often underutilized or unutilized. The research was carried out to assess the potential of incorporating okara in bakery products to improve the nutritional quality. Fresh okara was dried, ground and sieved to obtained fine flour. The okara flour was then incorporated in bun making by substituting with wheat flour at 5, 10 and 15%. The standard method for bun preparation was used without changing the other ingredients. The developed buns were then analysed for their sensory, physical and nutritional quality. By far much better, the results improved the proximate composition of the buns. Proteins, fat, ash and fibre were increased while carbohydrate content was reduced greatly with incorporation of okara flour. The addition of okara flour at higher percentages greatly reduced the physical characteristics (volume, specific volume, height and dough raising capacity) values of the buns due to the dilution of the gluten network and increased fibre content. The sensory parameters of colour and appearance, aroma and taste were not significantly different from control buns while elasticity and texture score rating were greatly reduced. Overall, the buns were accepted at 5% level of incorporation which could be increased by using bread improvers to improve the physical properties. The use of okara flour can therefore be used in buns and other bakery products to improve the nutritional quality and help in food security.

*Key words: soy okara, buns, sensory, physical and nutritional properties.*

## Introduction

Soya bean is an alternative protein source to the rural families and can be utilized at home in various forms and the surplus can be sold to other consumers and manufacturers for income.

Soya beans are highly digestible, high in unsaturated fatty acids and contain no cholesterol (Singh et. al. 1987).

In Malawi the crop has been produced as early as the 70s, however it was towards the end of the 1980's that the production of Soya beans picked up. In 1989 Soya bean was substituted for common beans and ground nuts in *Likuni Phala* (Ministry of Health 1992). Attempts have been made to promote the utilization of Soya beans at household level by various interest groups including UNICEF, Ministry of Agriculture, University of Malawi (Bunda College of Agriculture) and the Ministry of Health (FAO/MOALD 1997). Much of this promotional work was targeted at small holder farmers who are the major producers of Soya beans. These farmers were growing Soya beans as cash crop. However the majority of the people in the rural areas are at an increased risk in terms of Protein energy malnutrition. The drive behind these promotional efforts was the potential of Soya beans in improving the nutrient value of the predominantly maize based Malawian diet.

Soybean and soy products are relatively inexpensive source of proteins that are widely recognised for their high nutritional and excellent functional properties. Among various soy foods, soy milk and tofu are becoming more popular as low cost substitutes of traditional dairy products for common masses and an ideal nutritional supplement for lactose intolerant (Biranjan et al., 1982). The by-product obtained during processing of soybean is either underutilized or unutilized. Okara (insoluble residue from tofu or soymilk) and whey are two major by-products of the tofu making process. These can be put in a number of uses which can serve as potential sources of income and utilize their nutrients. Okara is not only a rich source of dietary fibre but it also contains higher quality protein (as measure by PER) than any other fraction in the tofu making process. With importance of the growing awareness of the importance of crude fibre in human diets, okara can be utilized in foods specially formulated with high fibre content (Tripathi and Jha, 2011).

Buns and breads prepared from refined wheat flour are deficient in proteins, vitamins, minerals and fibre. There is therefore need to replace the nutrients which are lost through the process of refining and also to enhance the nutritional content of these baked products. The research was therefore carried out to assess the potential of utilizing dried okara flour in buns to improve the nutrition quality and thus making use of it instead of discarding. The main objectives being to assess the effects of adding okara flour on the sensory, physical and nutritional quality of the buns.

## Materials and methods

The ingredients for preparation of buns (wheat flour, sugar, common salt, milk powder, dry yeast, and fat) were procured from local shops, while fresh soy okara was procured from Mahakaushal Associates in Adhartal, Jabalpur (M.P.). The fresh okara was dried in Air Oven drier and then ground to make fine granules of flour. Preliminary studies were conducted to standardize the recipe for the development of garden cress buns and also to establish the percentage of supplementation through sensory evaluation. The basic recipe for buns from Kamaliya (2002) was used as a basis and then modified through different trials to suit this study. The important attributes to sensory quality in bakery products: colour and appearance, aroma, taste, texture and overall acceptability, were assessed by 15 semi-trained panellists on a 9 point hedonic scale ranging from 1 to 9 (dislike extremely to like extremely) as given by Amerine et al, (1965).

The physical properties (weight, height, area) were measured by a weighing scale and measuring scale respectively. Loaf volume was measured using mustard seed displacement and specific volume was calculated from the loaf volume and weight. Dough raising capacity was calculated by placing dough after kneading in 500ml beaker for fermentation for $1^1/_2$ hours at $38^0$C, and taking the volume before and after fermentation (Kamaliya, 2002).

Moisture was analyzed using the MBS4 Moisture analyzer, while ash, protein and carbohydrate were determined by standard methods given by AOAC (1992). Fat was analyzed by extraction method using petroleum ether using SOCS PLUS Pelican equipment as given by AOAC (1992). Crude fiber was calculated by difference method whereas energy value was calculated by factorial method using factors 4, 4 and 9 for carbohydrates, protein and fat respectively. The mineral content of buns was obtained by calculation based on table values.

## Results and discussion

### Sensory analysis

Table 1: Sensory attributes of okara buns (mean scores)

| Bun Type | CC | CCA | A | Tx | T | CE | OA |
|---|---|---|---|---|---|---|---|
| Control | 9.00 | 9.00 | 8.50 | 9.00 | 9.00 | 8.50 | 9.00 |
| 5% okara | 9.00 | 9.00 | 8.00 | 7.00 | 9.00 | 7.00 | 8.00 |
| 10% okara | 8.20 | 8.60 | 7.00 | 6.00 | 7.00 | 6.00 | 7.50 |
| 15% okara | 7.50 | 7.50 | 6.00 | 5.00 | 6.00 | 5.00 | 6.00 |
| SEM | 0.43 | 0.16 | 0.36 | 0.66 | 0.32 | 0.66 | 0.41 |
| CD at 5% | 1.94 | 0.70 | 1.61 | 2.98 | 1.45 | 2.98 | 1.84 |

*CC = crust colour, CCA = crumb colour and appearance, A = Aroma, Tx = texture, CE = Crumb elasticity and OA = overall acceptability.*

The sensory analysis results are given in table 1. The results of bun crust and crumb colour did not show a consistent pattern among the okara buns and no significant difference with control buns even at higher percentages. At higher percentages, the crust colour changed from creamy white to dull brown. The darker crust colour may be because of the greater maillard reaction between reducing sugars and proteins (Raidi & Klein, 1983). Similar findings were also reported by Dhingra and Jood (2004) and Lapvetelainen et al., (2006). In terms of texture, addition of okara flour affected the softness/hardness of the buns. Okara buns were soft up to 5%, above which they gave a hard and coarse crust and crumb structure and enlarged grain size due to increased amount of fibre. Dhingra and Jood (2004) also reported a decrease in crust texture score with increase in the substitution of barley and defatted soy flour. The taste and aroma were acceptable up to 15% of substitution while crumb elasticity was reduced by addition of okara. This is due to dough weakening due to decreased amount of gluten protein which reduces the extensibility and resistance. Overall, okara buns were organoleptically acceptable up to 5% level of supplementation. However, if bread improvers are used to improve the texture and physical properties, the acceptance level can be raised to 10%.

## Physical characteristics

Table 2: Physical characteristics of Soy okara buns

| **Bun Type** | **Volume (ml)** | **SV (ml/gm)** | **Height (cm)** | **Area (cm2)** | **Weight (gm)** | **DRC (%)** |
|---|---|---|---|---|---|---|
| Control | 121.67 | 2.08 | 4.70 | 35.00 | 58.88 | 320 |
| 5% okara | 92.33 | 1.54 | 3.90 | 35.20 | 51.09 | 460 |
| 10% okara | 71.67 | 1.43 | 3.70 | 36.68 | 51.67 | 375 |
| 15% okara | 30.00 | 0.60 | 3.07 | 35.68 | 51.88 | 200 |
| SEM | 5.27 | 0.09 | 0.21 | 1.04 | 1.40 | |
| CD at 5% | 23.71 | 0.39 | 0.97 | NS | 6.31 | |

*SV = specific volume and DRC = dough raising capacity*

The results show that volume and specific volume were significantly reduced by the increased addition of okara flour. The highest values were obtained from control buns with 15% okara buns giving the lowest values. This is due to the dilution of gluten network, which in turn impairs gas retention rather than gas production (Dewettinek et al. 2008; Elleuch et al., 2011). The decreased volume because of addition of soy products was also reported by Ribotta et al., (2005). The study reported that soy products are harmful to gluten formation, dough extensibility properties, gas retention properties and bread quality. Increased supplementation of wheat flour with defatted soy flour reduced loaf volume and specific loaf volume drastically (Constandache, 2005; Rodriguez et al, 2006). Albert, (1997) and Gomes et al., (2002) reported that, the main problem with dietary fibre addition in baking is the significant reduction of loaf volume and the different texture of the breads obtained. The height of okara buns was reduced significantly because soy okara dough could not retain $CO_2$

produced during proofing resulting in depression of the dough during baking. This is in line with the study conducted by Ribotta et al. (2005), who reported that soy flours produced a gluten network more permeable to $CO_2$. There was no consistent pattern in weight and area among all the buns. The dough raising capacity was increased by addition of okara up to 10%, after which it was decreased. This is due to high levels of dietary fibre and the interaction between the gluten protein and the soy protein.

## Proximate analysis

Table 3: Proximate analysis of soy okara buns (%)

| **Bun Type** | **Carbo-hydrates** | **Proteins** | **Fat** | **Ash** | **MC** | **Fibre** | **EV (Kcal)** |
|---|---|---|---|---|---|---|---|
| Control | 62.39 | 2.04 | 3.87 | 1.39 | 30.28 | 0.03 | 292.55 |
| 5% okara | 62.07 | 2.34 | 5.76 | 1.46 | 26.07 | 1.61 | 308.88 |
| 10% okara | 59.91 | 5.91 | 6.82 | 1.91 | 22.05 | 3.65 | 314.24 |
| 15% okara | 58.38 | 6.79 | 8.80 | 2.13 | 19.08 | 4.82 | 339.88 |
| SEM | 2.11 | 0.46 | 0.39 | 0.02 | 0.57 | - | - |
| CD at 5% | 9.50 | 2.06 | 1.77 | 0.10 | 2.59 | - | - |

*MC = Moisture content and EV = Energy value,*

The results of the nutritional composition of the nutraceutical buns as compared to control buns are in given in table 3. The addition of okara flour greatly increased protein, fat, ash and fibre content of the buns, while carbohydrate and moisture content were reduced. Earlier studies have reported increase in proximate composition with increased supplementation of flaxseed, soy flour, garden cress and oat flour. Rani et al. (2008) reported that supplementation of 15% soy flour significantly improved the fat, protein, ash, crude fibre and energy content of bread and biscuits. The higher values of protein, fat, crude fibre and ash was attributed to the higher protein, fat, crude fibre and ash content of soy flour (Gopalan et al. 2000). The moisture content of 5% okara buns were not significantly different (P = 5%), while at 10 and 15%, the percentage moisture was very low. This then entails that there was increase in water requirement for the preparation of dough. It has been reported in other studies that addition of non wheat flour increases the water absorption/retention capacity of bread. Increased fibre content is associated with high moisture content of bread. However in this study, the same amount of water was used regardless of the addition of the nutraceutical ingredients with the only difference being the percentage amount of wheat flour.

Rani et al. (2008) found that incorporation of 15% soy flour in bread recipes increased protein by 23-33% in bread and 17% increase in cake. Dhingra and Jood, (2001) found that increasing the level of substitution from 5 to 10% of full fat and defatted soy flour to wheat flour significantly ($P<0.05$) increased protein from 12.1 to 13.7 and 12.4 to 13.8% respectively and fat from 5.44 to 6.86% with 10% substitution . Other studies have also reported increase in protein content in composite breads with soy-flour substitution (Olaoye et al. 2006, Mashayekh et al. 2008, Ndife et al. (2011). This is in line with the results by Olaoye et al. (2006) who reported a decrease in carbohydrates content with increased percentage of soy flour, and Ndife et al. (2011) reported low carbohydrate and energy values in composite breads supplemented with soy flour. Similar trend was reported by Serem et al. (2011) in the fortification of wheat flour with defatted soy flour. There was increase in energy values for the okara incorporated buns with increased substitution. This may be contributed by the higher percentages of fat content of nutraceutical buns as already shown in the results.

### Nutraceutical content

The incorporation of okara buns increased the amount of isoflavones with increasing levels of substitution. It can be seen that there were no isoflavones in control buns, but with addition of okara flour, the total isoflavones were increased from 0.676mg at 5% to 1.351mg at 10% and to 2.027mg at 15% incorporation. Similarly Daidzen and Genistein increased from 0.270mg to 0.809mg and 0.324mg to 0.972mg respectively for 5% and 15% okara buns. The soy isoflavones are known to help in treating hypertension, high cholesterol, menopause symptoms, osteoporosis among other diseases. These okara buns can therefore be used to improve the health of the human population.

## Conclusion

Soy okara which is normally underutilized and unutilized was successfully incorporated in buns and significantly improved the nutritional content of the buns. These buns with elevated levels of fibres, isoflavones and proximate composition can be produced on an industrial scale as well as at household level. Content of dietary fibre, fat, protein was significantly higher in okara buns than in control buns. This is good as high fibre foods are being recommended for the gastrointestinal health and for prevention of cardiovascular diseases. The high protein buns produced from the okara supplementation would be of nutritional importance in most developing countries where many people struggle to get high proteinous foods because of their expensive costs. Thus, instead of being wasted, okara can provide addition food source to make food available to families. It is recommended to explore many other ways in which soy okara can be utilized locally.

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