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EFFECT OF SOLAR TUNNEL AND FREEZE DRYING TECHNIQUES ON THE ORGANOLEPTIC ACCEPTABILITY OF PRODUCTS PREPARED INCORPORATING OKARA (SOY BY-PRODUCT)

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ABSTRACT

An attempt has been made in the present investigation to observe the effect of solar tunnel drying and freeze drying techniques on the organoleptic acceptability of products developed by incorporating okara which was extracted, processed (dried) and powdered from variety PS-1347. Five products namely doughnuts, macroni, cake-rusk, noodles and butter cookies were prepared by incorporating various proportions (10, 20 and 30 per cent) of processed okara. It was observed that noodles, macroni and cake rusk of freeze dried okara were most acceptable at 30% level and fell in the category between liked moderately and liked very much by having 7.9, 7.7 and 7.6 overall mean scores, respectively. Whereas, doughnuts and butter cookies prepared by substituting 20% solar tunnel dried okara were found most acceptable having 7.5 and 7.8 mean scores, respectively.

Key words: Okara, Solar tunnel drying, Freeze drying, Products & Organoleptic evaluation

INTRODUCTION

Okara, a by-product of soymilk and tofu manufacturing, is potentially a nutrient-rich by-product produced from soybean contained about 25% protein, 20% fat and 33% dietary fiber on dry basis (O'Toole, 1999). However, analysis by the AOAC method revealed okara having 55.48g/100g dry matter of fiber versus 24.36g/100g dry matter for soybean seeds. Tortillas were prepared supplementing okara in an attempt to increase the protein content and found the maximum acceptable supplementation of okara was only 10% (Waliszewski *et al.,* 2002). 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 such as tempeh (Riaz, 2006). Several studies (Tsubaki, 2009; Grizotto *et al.* 2010) have been conducted on different processing, cooking methods and development of value added products of soybean but the information is still lacking on the effect of drying on nutritional composition, acceptability and shelf life of value added products based on okara. Keeping in view the above facts in mind and health promoting effects of okara, the present investigation was undertaken.

MATERIAL AND METHODS

The seeds of soybean, PS-1347 were procured in a single lot from the Pulse section Department of Genetics and Plant Breeding, College of Agriculture, CCS HAU, Hisar. The fresh okara was extracted from soybean seeds in the Department of Processing and Food Engineering, College of Agriculture Engineering and Technology, CCS HAU, Hisar, using hot disintegration method and then fresh okara was dried under solar tunnel dryer and benchtop freeze dryer and used for the development of various products namely noodles, macroni, butter cookies, cake-rusk and doughnuts at 10, 20 and 30 percent level. The detailed method of preparation of products is given in Table-I.

ORGANOLEPTIC EVALUATION OF PRODUCTS

All the products prepared by incorporating freeze dried and solar tunnel dried okara powder were subjected to sensory evaluation in terms of colour, appearance, texture, aroma and taste by a panel of ten judges using 9-point hedonic scale. The judges were selected from I.C. College of Home Science, CCS Haryana Agricultural University, Hisar.

RESULTS AND DISCUSSION

Results obtained on organoleptic evaluation of various products including freeze dried and solar tunnel dried okara powder including noodles, macroni, butter cookies, cake-rusk and doughnuts are discussed below:

Product	Ingredients	Method of preparation
Noodles	Raw noodles (Refined flour-70g, freeze dried okara powder -30g), onion-25g, capsicum-30g, cabbage-30g, green chilli sauce -1tsp, tomato sauce-1 tsp, soya sauce-1tsp, black pepper-1pinch, salt to taste, oil- 25 ml.	Wash vegetables. Cut onion, capsicum and cabbage length wise. Boil noodles with one teaspoon oil. Heat oil in pan, add onion and fry till golden brown then add capsicum and cabbage and fry for 5 minutes. Add green chilli sauce, tomato sauce, soya sauce and salt and stir for 2 minutes. Add boiled noodles and stir continuously for 2 minutes.
Macroni	Raw macroni (Refined flour-80g, freeze dried okara powder -20g), onion-25g, capsicum-30g, tomatoes-30g, tomato sauce-1 tsp, black pepper-1pinch, turmeric powder-1/2 tsp, red chilli powder-1/4 tsp, salt to taste, oil -25 ml.	Wash vegetables. Cut onion and capsicum are cut length wise and tomatoes to small cubes. Boil macroni with one teaspoon oil. Heat oil in pan, add onion and fry till golden brown then add capsicum and fry for few minutes finally add tomatoes and stir for 2 minutes. Add all the spices and boiled macroni and stir continuously for 5 minutes.
Butter-cookies	Refined flour-80g, solar tunnel dried okara powder -20g, custard powder-10g, butter-110g, icing sugar-40g, vanilla essence - 3-4 drops, baking powder-3/4 tsp.	Mix refined flour, solar tunnel dried okara powder, baking powder and custard powder. Cream butter and sugar and beat till fluffy then add vanilla. Sift the flour mixture and beat slowly with electric beater and then knead the flour. Wrap it in thin plastic film by rolling it in tubes and refrigerate it for 15-20 minutes. Pre heat oven at 180ºc / 365ºF. Cut into 1cm thick slice, give texture by fork and grease the trays and bake for 20-25 minutes.
Cake- rusk	Refined flour-80g, freeze dried okara powder-20g, eggs-2, butter-100g, powdered sugar-30g, baking powder-3/4tsp, milk-30ml, vanilla essence-2-3 drops	Preheat oven to 180ºc. Grease the tin having edge 8cm. Sift together flour, freeze dried okara powder and baking powder. Cream butter and powdered sugar then mix egg followed by vanilla and beat. Add flour mixture and apply cut and fold method. Pour batter into prepared tin and bake for 40-45 minutes. Cut the cake into 2cm thick slice and bake it for 20-25 minutes.
Doughnuts	Refined flour-80g, solar tunnel dried okara - 20g, butter- 45g, caster sugar-20g, dried yeast-1/2 tsp, egg yolks- 3, milk-80ml, oil for frying, castor sugar-120g	Combine flour, sugar, yeast and salt in a bowl and mix in milk, egg yolk and butter until dough starts to come together. knead well and wrap with greased thin plastic film and proof it for 4 hours or till the dough size doubled. Punch down the dough, knead on lightly floured surface for 2 minutes. Rollout to 1 cm thick, cut into circular shapes rest aside for rise then deep fry and sprinkle sugar.

NOODLES

Among noodles T-III i.e. 30 percent level of freeze dried okara powder incorporation was most acceptable which fell in the category of 'liked very much' in terms of colour (7.90), appearance (7.90), aroma (7.80), texture (7.85), taste (7.95) and overall acceptability (7.90) (Table.1.).

MACRONI

Maximum acceptability in macroni was at 20 percent incorporation of freeze dried okara powder which gained mximum mean scores as colour (7.75), appearance (7.70), aroma (7.87), texture (7.85), taste (7.72) and overall acceptability (7.77) which fell in the category between 'liked moderately' and 'liked very much'(Table.2.).

BUTTER COOKIES

Among butter cookies T-II of solar tunnel dried okara powder incorporation was 'liked very much' at 20 percent level with overall acceptability and mean scores are 7.81, 7.85, 7.80, 7.80, 7.91 and 7.85 in terms of colour, appearance aroma, texture, taste and overall acceptability(Table.3.).

CAKE-RUSK

T-II of freeze dried okara powder made cake-rusk was maximally accepted and gained mean scores as colour (7.75), appearance (7.77), aroma (7.55), texture (7.68), taste (7.70) and overall acceptability (7.67) which approaches towards 'liked very much'(Table.4.).

DOUGHNUTS

Solar tunnel dried okara powder incorporation at 20 percent level in doughnuts was 'liked very much' with colour (7.60), appearance (7.56), aroma (7.55), texture (7.58), taste (7.62) and overall acceptability (7.55) (Table.5.).

Table 1- Sensory characteristics of noodles

Products	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Noodles STDOP						
Control (RF)	7.90± 0.16	7.84±0.22	7.95±0.13	7.90±0.20	7.95±0.16	7.95±0.10
T-I (RF:STDOP::90:10)	7.25± 0.26	7.45±0.16	7.15±0.18	7.30±0.20	7.35±0.20	7.30±0.14
T-II (RF:STDOP::80:20)	7.00± 0.20	6.90±0.23	6.75±0.19	7.80±0.17	6.65±0.15	6.80±0.13
T-III (RF:STDOP::70:30)	6.03± 0.18	5.90±0.17	6.05±0.13	5.55±0.19	5.51±0.19	5.75±0.18
Noodles (FDOP)						
T-I (RF: FDOP::90:10)	7.90± 0.07	7.55±0.14	8.15±0.11	7.65±0.15	7.95±0.25	7.80±0.17
T-II (RF:FDOP::80:20)	7.25± 0.27	7.50±0.13	7.15±0.21	7.25±0.23	7.35±0.20	7.30±0.13
T-III (RF:FDOP::70:30)	7.90± 0.21	7.98±0.18	7.89±0.23	7.93±0.18	7.95±0.20	7.94±0.19

Values are mean ± SE of ten independent determinations. STDOP-Solar tunnel dried okara powder, FDOP-Freeze dried okara powder

Table 2- Sensory characteristics macroni

Products	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Macroni STDOP						
Control (RF)	8.20± 0.11	8.15±0.12	8.15±0.13	8.25±0.08	8.15±0.21	8.17±0.10
T-I (RF:STDOP::90:10)	7.15± 0.20	7.25±0.26	7.15±0.17	7.20±0.20	6.90±0.20	7.10±0.14
T-II (RF:STDOP::80:20)	7.10± 0.20	6.90±0.25	7.05±0.26	7.10±0.17	6.95±0.19	7.00±0.19
T-III (RF:STDOP::70:30)	6.00± 0.16	6.25±0.16	6.15±0.13	6.25±0.23	6.23±0.19	6.25±0.18
Macroni (FDOP)						
T-I (RF: FDOP::90:10)	7.30± 0.17	7.25±0.15	7.35±0.12	7.15±0.15	7.15±0.21	7.30±0.13
T-II (RF:FDOP::80:20)	7.75± 0.20	7.70±0.18	7.87±0.21	7.85±0.22	7.72±0.20	7.77±0.16
T-III (RF:FDOP::70:30)	7.10± 0.21	7.20±0.11	7.65±0.20	7.60±0.19	7.70±0.19	7.75±0.18

Values are mean ± SE of ten independent determinations. STDOP-Solar tunnel dried okara powder, FDOP-Freeze dried okara powder

Table 3- Sensory characteristics of butter-cookies

Products	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Butter cookies STDOP						
Control (RF)	8.00± 0.19	8.05±0.17	7.95±0.13	7.97±0.18	8.00±0.20	8.02±0.18
T-I (RF:STDOP::90:10)	7.45± 0.26	7.40 ±0.16	7.42±0.20	7.30±0.22	7.39±0.20	7.35±0.14
T-II (RF:STDOP::80:20)	7.81± 0.20	7.85±0.21	7.80±0.19	7.80±0.17	7.91±0.15	7.85±0.16
T-III (RF:STDOP::70:30)	6.00± 0.18	5.95±0.16	6.05±0.15	5.25±0.20	5.51±0.19	5.85±0.18
Butter cookies (FDOP)						
T-I (RF: FDOP::90:10)	7.50± 0.07	7.55±0.14	7.15±0.11	7.45±0.15	7.55±0.25	7.50±0.17
T-II (RF:FDOP::80:20)	7.25± 0.27	7.50±0.13	7.15±0.21	7.25±0.23	7.35±0.20	7.30±0.13
T-III (RF:FDOP::70:30)	6.10± 0.21	6.00±0.20	6.55±0.23	6.50±0.20	6.45±0.19	6.48±0.18

Values are mean ± SE of ten independent determinations. STDOP-Solar tunnel dried okara powder,   FDOP-Freeze dried okara powder

Table 4- Sensory characteristics of cake-rusk

Products	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Cake-rusk STDOP						
Control (RF)	7.60± 0.16	7.66±0.22	7.65±0.13	7.70±0.20	7.95±0.16	7.70±0.10
T-I (RF:STDOP::90:10)	7.25± 0.26	7.45±0.16	7.15±0.18	7.30±0.20	7.35±0.20	7.30±0.14
T-II (RF:STDOP::80:20)	7.00± 0.20	6.90±0.23	6.75±0.19	7.80±0.17	6.65±0.15	6.80±0.13
T-III (RF:STDOP::70:30)	6.00± 0.15	5.95±0.17	6.15±0.13	5.45±0.20	5.51±0.19	5.62±0.18

Cake-rusk (FDOP)						
T-I (RF: FDOP::90:10)	7.15± 0.07	7.20±0.14	7.15±0.13	7.35±0.15	7.25±0.25	7.20±0.17
T-II (RF:FDOP::80:20)	7.75± 0.27	7.77±0.13	7.55±0.21	7.68±0.23	7.70±0.20	7.67±0.13
T-III (RF:FDOP::70:30)	6.05± 0.20	6.30±0.11	6.00±0.21	6.40±0.20	5.80±0.18	6.18±0.18

Values are mean ± SE of ten independent determinations. STDOP-Solar tunnel dried okara powder, FDOP-Freeze dried okara powder

Table 5- Sensory characteristics of doughnuts

Products	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Doughnuts STDOP						
Control (RF)	8.10± 0.17	8.25±0.16	8.15±0.19	8.35±0.12	8.20±0.19	8.22±0.10
T-I (RF:STDOP::90:10)	7.25± 0.22	7.15±0.16	7.25±0.15	7.10±0.19	7.15±0.20	7.25±0.14
T-II (RF:STDOP::80:20)	7.60± 0.20	7.56±0.23	7.55±0.19	7.58±0.17	7.62±0.15	7.55±0.13
T-III (RF:STDOP::70:30)	6.00± 0.18	5.88±0.16	6.16±0.13	5.25±0.23	5.51±0.19	5.85±0.18
Doughnuts (FDOP)						
T-I (RF: FDOP::90:10)	7.20± 0.07	7.25±0.14	7.15±0.11	7.20±0.15	7.35±0.25	7.30±0.17
T-II (RF:FDOP::80:20)	7.25± 0.27	7.40±0.13	7.15±0.21	7.25±0.23	7.40±0.20	7.35±0.13
T-III (RF:FDOP::70:30)	6.10± 0.21	6.00±0.11	6.85±0.23	6.20±0.20	6.15±0.19	6.75±0.18

Values are mean ± SE of ten independent determinations. STDOP-Solar tunnel dried okara powder, FDOP-Freeze dried okara powder

CONCLUSION

It was observed that noodles, macroni and cake rusk of freeze dried okara powder were most acceptable at 30% level and fell in the category between liked moderately and liked very much by having 7.9, 7.7 and 7.6 overall mean scores, respectivelyThis was due to less beany smell, negligible changes in colour after drying and uniformity in drying of okara. Whereas, chocolate doughnuts and butter cookies prepared by substituting 20% solar tunnel dried okara powder were found most acceptable by having 7.5 and 7.8 mean scores, respectively.This was due to slight beany smell, non uniformity in drying which leads to changes in color because of the fluctuation in temperature. Thus overall acceptance of freeze dried okara powder in products was maximally accepted then solar tunnel dried powder.

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