Madras Agric. J., 101 (7-9): 284-288, September 2014
https://doi.org/10.29321/MAJ.10.001199

Development of Pasta and Extrudates Enriched with Omega-3 Fatty Acid and Saponin

K. Gomathy[1*], M. Balakrishnan[1]and A.Dhivya [2]
[1]Department of Food and Agricultural Process Engineering,
Tamil Nadu Agricultural University, Coimbatore
[2]Annamalai University, Annamalainagar.

Pasta and extrudates are a versatile, nutritious, economical and increasingly international food. In this study, an attempt has been made to develop a pasta and extrudates enriched with omega 3 fatty acid and saponin. Flax seed (*Linum usitatissimum*), rich in omega 3 fatty acid, and vallarai (*Centella asiatica* L), good source of antioxidant saponin were selected for this study. Experiments were carried out using both germinated and ungerminated flax seed powder in combination with vallarai. The pasta and extrudates made out of ungerminated flax seed were found to have greater amounts of antioxidant and iodine value compared to the products made using germinated flax seed. It was concluded that the pasta made with a composition of 10% vallarai and 20% ungerminated flax seed with maida as a base material and extrudates made of rice flour, 10% soy flour, 20% ungerminated flax seed powder and 10% vallarai were adjudged as the best samples based on the biochemical and sensory attributes.

Key words: Omega 3 fatty acid, Saponin, Pasta, Extrudates Flax seed, Vallara leaves, Antixidant value, Iodine value

Extrusion technology is one of the fastest growing and most important food processing operation (Harper, 1981). Extrusion cooking has become established industrial technology with a number of food and feed application (Cheftel *et al.,* 1985). It is used worldwide for the production of expanded snack foods, modified starch, ready to eat cereals, baby foods, pasta and pet foods (Linko *et al*., 1984). Extrusion is the multivariable operation which involves mixing, shearing, cooking, puffing and drying in one energy efficient rapid continuous process (Banerjee *et al.,* 1998). Pasta, an extruded product, is a source of carbohydrate (74–77%, db) and its interest is increasing due to its nutritional properties, particularly its low glycaemic index (GI) (Monge *et al.,* 1990). Pasta is forced through small cylinders/ pipes and into tubes, ribbons and other shapes. The organized sector produces 35,000 tonnes per annum, which are mostly branded vermicelli. The unorganized sector produces 200,000 tonnes (Vidhya *et al.,* 2008). Fortification in pasta products has been carried from a long period of time in order to improve its nutritional quality. Unlike the commonly incorporated nutrients like protein, vitamins, carotene *etc*., enrichment with omega 3 fatty acid and saponin serves the essential need and health benefits of human body.

Flax seed (*Linum usitatissimum*), an ancient oilseed belongs to the Linaceae family. It is an excellent source of omega-3 essential fatty acid *i.e.* alpha linolenic acid (ALA). The active ingredient of flaxseed (lignan, secoisolariciresinol diglucoside (SDG)) has significant antioxidant effects by inhibiting DNA scissions and lipid peroxidation (Kitts *et al*., 1999). The flax seed also has significant anti-inflammatory effects (Cohen *et al.,* 2005). The soluble fibre removes cholesterol from gastro intestinal tract and lowers bowel fermentation to short chain fatty acids that suppresses cholesterol production. Therefore, it is suggested that flax seed supplementation could be an excellent way to lower the risk of heart disease.

Bioactive compounds in plants are considered to be critical for human health. One such medicinal plant is Vallarai *(Centella asiatica* L*.),* which belongs to the family Apiaceae (Umbelliferae). This green leafy vegetable contains biochemical constituents such as asiaticoside, asiatic acid and madecassic acid, which serve as the active ingredients supporting the body's vitality (Narayana Das *et al*., 2003).

Keeping in view the importance of fortification of flax seed and vallarai with maida as a base material for pasta and with rice flour as a base material for extrudates, this study was conducted with an aim to incorporate omega-3 fatty acid (flax seed) and saponin (vallarai) in pasta and extruded products to make it highly nutritious.

Materials and Methods

Raw materials like maida, corn flour, soy flour

[1]*Corresponding author

and rice flour were procured from well established supermarket. The flours were sieved using ISS 40 sieve for the experiments. Fresh vallarai green leafy vegetable free from pests and diseases was procured from a progressive farmer to get consistent quality raw materials for the experiments. The bunches were carefully dehanded and washed in potable water to remove adhering soil, dirt etc, .and it was ground into a paste using mixer. Flax seed, free from dust, dirt and insects, was procured from a well established supermarket. The flax seeds were germinated, sun dried and ground for use in the experiments. The flour was sieved using ISS 100 sieve and incorporated for use in the experiments to increase its nutrient availability in the body.

The ingredients such as germinated and ungerminated flax seed powder, vallarai paste, salt, maida were used for making pasta using pasta making machine (M/s, LB ITALIA). The pasta was prepared with three levels of germinated and ungerminated flax seed powder namely, 15, 20 and 25% and three levels of vallarai namely, 5, 10 and 15% keeping maida as base material along with water (30%).

The optimum levels of flax seed and vallarai was used for further preparation of extruded products. A twin screw extruder (M/s, Basic Technology Private Limited, Kolkatta) was used for the production of extrudates. The raw ingredients such as germinated, ungerminated flax seed powder, vallarai paste, salt, rice flour, corn flour, soy flour were fed to produce extrudates under different combinations.

Cooking time

A sample of pasta was 10 g of cooked in 160 ml distilled water. The optimal cooking time was determined visually by pressing such strands between two plates for the starchy white core of the pasta to disappear (Zweifel *et al*., 2003).

Water uptakse

Water absorption in ml was calculated by relating the gain in weight between dry and cooked pasta.

Cooking volume

The difference in the volume of the pasta before and after cooking to a predetermined time was calculated using a measuring cylinder.

Expansion ratio

The diameter at different locations along the strand of an extrudate was measured and the expansion ratio was calculated by dividing the average diameter of the strand by the diameter of the die.

$$\text{Expansion ratio} = \frac{\text{Diameter of a ring shaped extruded sample (mm)}}{\text{Diameter of the die outlet (mm)}}$$

Bio chemical analysis of pasta and extrudates

Iodine value

The iodine value is a measure of the degree of unsaturation in oil. The reagents such as chloroform, hanus iodine solution, 15 % potassium iodide and 1% starch indicator were added to the sample. It was titrated against 0.1N sodium thiosulphate until yellow solution turned colourless. The iodine value of the sample was estimated using the following formula

$$\text{Iodine number} = \frac{(B-S) \times N \times 12.69}{\text{Sample weight (g)}} \quad \ldots\ldots\ldots (1)$$

B = thiosulphate for blank, ml

S = thiosulphate for sample, ml

N = normality of thiosulphate solution

Antioxidant activity

The antioxidant Activity was determined using FRAP (Ferric Reducing Antioxidant Power) Assay. The reagents used were acetate buffer, TPTZ (10 mmol/l), ferric Chloride (20 mmol) [freshly prepared], FRAP (Ferric Reducing Antioxidant Power) working solution and ascorbic acid (1mM) stock standard. Aliquots of 0.2 to 1ml were pipetted out in test tubes. The volume was made up to 1 ml in each tube with water. Then 0.5ml FRAP reagent was added. After a period of 10 minutes the absorbance was measured at 593nm.

Moisture content

Moisture content was determined using vacuum oven method. The oven was run at a pressure of 25mm of Hg at 98-100°C for a period of 5 h (AOAC Method No. 925.09, 2000). The moisture content was determined using the following equation,

$$\text{Moisture content, \% d.b.} = \frac{\text{Initial weight-Final weight, g}}{\text{Final weight, g}} \times 100 \quad \ldots\ldots\ldots (2)$$

Sensory evaluation of pasta

Hedonic sensory evaluation was conducted by 16 trained panelists consisting of food science and food engineering faculty members. The panelists were asked to evaluate the hedonicity of appearance, colour, flavour, texture and overall acceptability of the pasta on a 9-point hedonic scale (ISI specification- IS 6272: 1991) ranging from 1 (most disliked) to 9 (most liked).

Statistical analysis

Data analysis was performed using AGRESS SOFTWARE (Factorial Completely Randomized Design) to optimize the combination of ingredients and to evaluate the quality attributes.

Table 1. Effect of germination on cooking qualities of pasta

Treatment	Germinated flax seed powder			Ungerminated flax seed powder		
	Cooking time (min)	Water uptake(ml)	Cooked volume (ml)	Cooking time (min)	Water uptake(ml)	Cooked volume (ml)
Maida+5%vallarai+15%flax seed powder	14	13	30	13	9	26
Maida+5%vallarai+20%flax seed powder	15	14	29	14	10	25
Maida+5%vallarai+25%flax seed powder	16	14	29	14	10	25
Maida+10%vallarai+15%flax seed powder	18	11	25	15	10	24
Maida+10%vallarai+20%flax seed powder	20	11	25	14	10	23
Maida+10%vallarai+25%flax seed powder	20	12	25	17	11	23
Maida+15%vallarai+15%flax seed powder	22	14	28	18	12	21
Maida+15%vallarai+20%flax seed powder	25	12	28	20	12	21
Maida+15%vallarai+25%flax seed powder	25	13	28	20	13	21

Results and Discussion

Effect of germination on cooking qualities of pasta

Cooking time

Table 1 represents the effect of germination of flax seed on cooking qualities of pasta. It was found that there was a reduction in the cooking time with germination of flax seed. The combination of 15% of vallarai and 25% of germinated/ungerminated flax seed powder recorded the highest cooking time compared to the product with the combination of 5% of vallarai and 15% of germinated/ungerminated flax seed powder. Statistically it was found that the combination of 5-10% vallarai and 15-25% flax seed powder were on par with each other and gave best results with respect to cooking time. This is due to the fact that during the process of germination, the cells are liberated and swell by absorbing water thus enhances cooking. Similar results have been reported by Kordylas (1990).

Water uptake

The effect of germination on water uptake of pasta made using germinated and ungerminated flax seed powder is shown in Table 1. The pasta made of germinated flax seed powder exhibited maximum water uptake compared to the one made with ungerminated flax seed powder. Similar trend was reported by Kordylas (1990). The combination of 15% vallarai + 20% flax seed powder and 10% vallarai+25% flax seed powder were found to be statistically on par with each other with respect to maximum water uptake.

Cooking volume

The effect of germination on cooking volume of pasta was represented in Table 1. It was observed that the sample with the combination of 5% of vallarai and 15% of flax seed recorded the highest cooking volume. The cooking volume was lower in the samples having combination of 15%, 20% and 25% of germinated flax seed with 10% vallarai. This may be owing to the decrease in the water uptake by the samples.

Expansion ratio

It was found from the Table 3 that the sample made out of rice flour, 10% corn flour, 20% germinated flax seed and 10% vallarai attained the maximum expansion ratio of 1.83 and samples made out of soy flour had the minimum expansion ratio of 1.5. This may be due to the higher starch content of the corn based extrudates and also the corn extrudates were found to have larger and smoother air cells than extrudates with high protein content. The same phenomenon was reported by Atienzo-Lazos *et al.,* (2011). Also it was observed that the sample prepared using rice flour, 10% corn flour, 20% ungerminated flax seed and 10% vallarai was found to attain the maximum expansion ratio of 2.2.and the extrudates prepared using rice flour, 10% soy flour, 20% ungerminated flax seed and 10% vallarai and rice flour, 15% soy flour, 20% ungerminated flax seed and 10% vallarai had the minimum expansion ratio of 1.6.

Quality attributes of psasta and extrudates

Iodine and antioxidant value

The flax seed powder contained an iodine value of 120.4 and an antioxidant value of 195 µg/g. While being incorporated in the ingredients for making pasta, it was found that there was a loss of 20 to 40% and 30 to 60% in antioxidant value and iodine value, respectively (Table 2). It was observed that the sample containing 5% vallarai and 15% germinated flax seed powder exhibited a minimum loss of 25.9% in iodine value whereas the maximum loss of 39.77% was observed in the sample having 15% vallarai and 25% germinated flax seed powder. The minimum loss of 30.76% in antioxidant value was observed in the sample with 15% vallarai and 20% germinated flax seed powder and a maximum loss of 57.6% was noticed in the sample containing 5% vallarai and 15% germinated flax seed powder.

Table 2. Effect of germination on biochemical qualities of pasta

Treatment	Germinated flax seed powder		Ungerminated flax seed powder	
	Antioxidant value (µg/g)	Iodine value	Antioxidant value (µg/g)	Iodine value
Maida+5%vallarai+15%flax seed powder	82.5	89.17	100.1	105.4
Maida+5%vallarai+20%flax seed powder	120	81.83	121	101
Maida+5%vallarai+25%flax seed powder	130	75.95	139	98
Maida+10%vallarai+15%flax seed powder	127.5	73.95	136	96
Maida+10%vallarai+20%flax seed powder	130	78.89	145	111.50
Maida+10%vallarai+25%flax seed powder	120	80.06	134	115
Maida+15%vallarai+15%flax seed powder	130	82.72	142	116.2
Maida+15%vallarai+20%flax seed powder	135	76.58	130	112
Maida+15%vallarai+25%flax seed powder	120	73.73	118	97

The ungerminated flax seed powder contained an iodine value of 121.97. During incorporation the loss ranged from 5 to 25% and 25 to 50% in iodine value and antioxidant value respectively. It was observed from Table 2 that the sample having a combination of 15% vallarai and 20% germinated flax seed powder, the per cent loss in iodine value was minimum and it was maximum in 5% vallarai and 20% ungerminated flax seed powder sample. The minimum loss of antioxidant value was observed as 25.6% in the sample having 10% vallarai and 20% ungerminated flax seed powder and a maximum loss of 48.6 % in the sample having 5% vallarai and 15% ungerminated flax seed powder.

Statistically, the pasta prepared using ungerminated flax seed powder has the maximum retention of antioxidant and iodine value and found to the best in comparison with pasta prepared using germinated flax seed powder. It was also observed that the pasta made with different formulation using flax seed powder and vallarai was found to have a significant effect ($P<0.01$) on the biochemical qualities of the pasta. The pasta with a formulation of 10% vallarai, 20%flax seed powder and 15% vallarai and 15% flax seed powder with maida as a base material were found to be on par and the best formulation with respect to biochemical qualities.

The loss may be due to the heat generated by the compression of the ingredients in the pasta making machine. Further, it was found that pasta produced using ungerminated flax seed powder had the best retention of biochemical qualities compared to the pasta made out of germinated flax seed powder. This may be due to the breakdown of fatty acids upon germination, which would have resulted in the decreased iodine and antioxidant value of the product.

From Table 3, it can be observed that the extrudate made of rice flour, 10% soy flour, 20% ungerminated flax seed and 10% vallarai was found to have the minimum loss of iodine value (18.08%) when compared to the extrudate made of rice flour, 20% corn flour, 20% un germinated flax seed and 10% vallarai which has maximum loss of 40.96%. It was inferred that the corn based product had the maximum loss in iodine value. This may be due to the high starch content in the corn flour.

Table 3. Effect of germination on bio chemical and physical property of extrudate

Treatment	Antioxidant value (µg/g)	Iodine value	Expansion ratio
Rice flour + Soy flour (10%) + Vallarai paste (10%) + Germinated flax seed powder (20%)	290	72	1.5
Rice flour + Soy flour (15%) + Vallarai paste (10%) + Germinated flax seed powder (20%)	280	64	1.5
Rice flour + Soy flour (20%) + Vallarai paste (10%) + Germinated flax seed powder (20%)	225	58	1.5
Rice flour + Corn flour (10%) + Vallarai paste (10%) + Germinated flax seed powder (20%)	145	62	1.83
Rice flour + Corn flour (15%) + Vallarai paste (10%) + Germinated flax seed powder (20%)	125	55	1.6
Rice flour + Corn flour (20%) + Vallarai paste (10%) + Germinated flax seed powder (20%)	120	53	1.66
Rice flour + Soy flour (10%) + Vallarai paste (10%) + ungerminated flax seed powder (20%)	280	99.91	1.6
Rice flour + Soy flour (15%) + Vallarai paste (10%) + ungerminated flax seed powder (20%)	268	90	1.6
Rice flour + Soy flour (20%) + Vallarai paste (10%) + ungerminated flax seed powder (20%)	235	84	1.7
Rice flour + Corn flour (10%) + Vallarai paste (10%) + ungerminated flax seed powder (20%)	158	90.76	2.2
Rice flour + Corn flour (15%) + Vallarai paste (10%) + ungerminated flax seed powder (20%)	120	78	1.8
Rice flour + Corn flour (20%) + Vallarai paste (10%) + ungerminated flax seed powder (20%)	110	72	1.8

Statistically, germination was found to have no significant effect upon the antioxidant value, whereas the extrudate prepared using ungerminated flax seed powder resulted in higher iodine value. The lower iodine value for the germinated flax seed powder compared to ungerminated flax seed powder may be due to the breakdown of the fatty acids during germination. It was also observed that

the extrudate made with different formulation using flax seed powder and vallarai was found to have a significant effect (P<0.01) on the biochemical qualities of the extrudate. The extrudate made of rice flour, 10% soy flour, 10% vallarai paste and 20% ungerminated flax seed powder was found to be statistically the best formulation with respect to the retention of the biochemical qualities of the extrudates.

Moisture content

The moisture content of the pasta was found to be ranging from 10% to 11.2% (d.b.).

Sensory analysis

The sensory evaluation was conducted for the pasta and extrudate using a trained panel. Based on the evaluation, the pasta with a formulation of 10% vallarai and 20% flax seed powder and the extrudate with a formulation of rice flour, 10% soy flour, 20% ungerminated flax seed powder and 10% vallarai was adjudged as the best formulation in terms of colour, appearance, flavor, texture, taste and overall acceptability.

Conclusion

It is concluded that the pasta made with a combination of 10% vallarai, 20% flax seed powder with maida as the base material is the best in terms of bio chemical, cooking qualities and sensory evaluation. It is also concluded that the germination of flax seed has no significant changes in the quality attributes of pasta. The extrudate with a formulation of rice flour, 10% corn flour, 20% flax seed and 10% vallarai is estimated to have the maximum expansion ratio. Combining the above analysis results it is determined that the sample made of rice flour, 10% soy flour, 20% ungerminated flax seed powder and 10% vallarai is the best among the extruded samples. The product fortified with ungerminated flax seed powder and vallarai is found to be acceptable, containing the highest amount of omega 3 fatty acids and saponins.

References

Association of Analytical Chemists. 2000. Official methods of analysis 17 th Ed., AOAC INTERNATIONAL, Gaithersburg, MD, Method 925.09

Atienzo-Lazos, M, Delgado, E, Ochoa-Martínez, A, Aguilar-Palazuelos, E, Martínez B.F, Ramirez-Wong, B, Gallegos-Infante, A, Medrano-Roldan, H and Solis-Soto A. 2011. Effect of moisture and temperature on the functional properties of composite flour extrudates from beans (*Phaseolus vulgaris*) and nixtamalized corn (*Zea mays*).*J. Animal Production Advance*., **1(1):** 9-20.

Banerjee, S, Bhattacharyya,S. and Chakraborthy, P. 1998. Extrusion processing of foods and Feeds*, Indian Food Industry*. **17(5):** 276-281.

Cheftal, J.C, Cuq, J. and Lerient, D.1985. Amino acid, peptides and protein, In: *Food Chemistry*., (Eds) O.Fennema, (Eds.), Marcel Dekker, New York, p. 246-369

Cohen, S, Moore, A. and Ward, W. 2005. Flaxseed oil and inflammation associated bone abnormalities in interleukin-10 knockout mice, *J. Nutr. Biochem.,* **16:** 368-374.

Indian Standard Institution. (1991). Sensory evaluation of foods. Part I.(IS: 6272-1991).

Kitts , D, Yuan, Y, Wijewickreme, A. and Thompson, L. 1999. Antioxidant activity of the flaxseed lignan secoisolariciresinol diglucoside and its mammalian lignan metabolites enterodiol and enterolactone, *Mol. Cell Biochem*., **202:** 91-100.

Kordylas, J.M. 1990. Processing and preservation of tropical and sub tropical foods, Macmillian Educational Ltd, Hampshire. p. 109-119.

Linko, P. P, Colonna, P and Mercier, C. 1981. High temperature short time extrusion cooking. *Advances in Cereal Science and Technology*. Vol. IV. (Ed). Pomeranz, Y., American Association of Cereal Chemists, Inc. St. Paul: 145-235.

Monge,L, Cortassa, G, Fiocchi, F, Mussino, G .and Carta, Q.1990. Glyco-insulinaemic response, digestion and intestinal absorption of the starch contained in two types of spaghetti Diabetes, *Nutrition and Metabolism*. p. 239–246.

Narayana Das, Praatathi, S.S, Purohit, A.K, Shama and Tarun kumar. 2003.*Handbook of Medicinal Plant*, Agro bios (India) publications.

Vidhya, M. and Aruna Narayanan, A.C. 2008. Storage Stability of Value Added Vermicelli, *Indian J. Nutrition Dietetics*. **45:** 298.

Zweifel, C, Handschin, S, Escher, F. and Conde-Petit, B. 2003. Influence of high temperature drying on structural and textural properties of durum wheat pasta, *Cereal Chem*., **80(2):** 159-167.

Received: June 20, 2013; Accepted: October 21, 2013