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Studies on formulation of cookies by using soy protein isolates from de-oiled soya meal

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Present investigation was undertaken to study the compatibility of de-oiled soy meal in preparation of Soy Protein Isolate and further to study formulation of cookies with different wheat flour and Soy Protein Isolate blend ratio. The raw material *i.e.* de-oiled soy meal was subjected for the proximate analysis to judge the suitability of raw material in preparation of the Soy Protein Isolate and it was also analyzed for the chemical composition. From the proximate analysis, it was found that Soy Protein Isolate contains 84.5% protein which justifies it was suitable as nutritional ingredient. Cookies were predominantly based on refined wheat flour (RWF) and Soy Protein Isolate (SPI) blended composite flour so as to upgrade the nutritional quality. Preliminary experimental work was done with different high levels of Soy Protein Isolate (SPI) incorporation so as to select the range of % incorporation which could be used in formulating composite flour for cookies. Through sensory evaluation by a panel of food scientists it was found that not more than 20% of SPI could be used in preparation of composite flour as further increase in SPI concentration resulted in drastic reduction of overall acceptability of product. Therefore cookies were prepared with incorporation of Soy Protein Isolate from 0% [control *i.e.* T_1(c)], 5% [T_2], 10% [T_3], 15% [T_4], 20% [T_5] and analyzed for their physical, chemical and organoleptic evaluation. Sample T_4 with 15% incorporation found to be superior with respect to all the aspects. Further increase in the Soy Protein Isolate level will reduce overall acceptability of the product.

Key Words : Soy protein isolate (SPI), De-oiled soy meal, Refined wheat flour (RWF), Soy cookies

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INTRODUCTION

Cereal based food products are part of stable diet of global population, where wheat is leading cereal crop and principally used in Bakery products due to its much appreciated rheological characteristics. However, wheat protein is deficient in some indispensible essential amino acids (Chastain *et al.*, 1995 and Carlson and Lersten, 1987). Composite flour technology for wheat supplementation with protein rich materials like soybean could be an approach to overcome the malnutrition. The growth of bakery industry is about 10% per annum and the products are increasingly becoming popular among all sections of people (Indrani *et al.*, 1997).

Cookies hold an important position in snack foods due to variety in taste, crispiness and digestibility. These are popular among all age groups especially in children's. Commercially available cookies are prepared from white flour that is nutritionally inferior to whole wheat flour (Hussain *et al.*, 2006).

'Cookie' is chemically leavened products also known as 'biscuit'. Generally the term biscuit is used in the European countries and cookies in the USA. Biscuits and

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biscuit like products have been made, eaten by man for centuries (Hosney, 1986). Cookies are ideal for nutrient availability, palatability, compactness and convenience. They differ from other bakery products like bread and cakes because of having low moisture content, comparatively free from microbial spoilage long shelf-life makes large scale production and distribution possible Cookies hold and important position in snack foods due to varieties in taste, crispiness and digestibility. At present cookies and biscuits are prepared from white flour which is inferior in quality and low in fibre content. Low levels of dietary fibre causes certain non infectious diseases such as diverticulitis, atherosclerosis and colonic cancer for this reason interest in research has arisen in increasing fibre content in the diet. Baked products have proved to be acceptable carriers of fibre from various sources.

Soybeans are species of legume that yields a valuable amount of oil that has a healthy fatty acid profile and high-quality protein that is replete in all the essential amino acids required for sustaining human nourishment (Young, 1991). Soybeans have antihypertensive, anti cholesterol, and antioxidant activities, and appear to prevent several types of cancer (Wu *et al.,* 1998 and Messina, 1995).

The plant is classed as an oilseed rather than a pulse by the Food and Agricultural Organization (FAO). Soybean production constitutes about 55% of the total world Production of Oilseed and Figures around 170-185 million tons. The Production of Soybean has showed an increase of 5.35% during last 10 years, around 30% of the world's total produce is traded annually. USA is leading producer of soybean followed by Brazil and Argentina. Soy products have been consumed in Asian countries such as China and Japan for many Centuries (Mian, 2006).

Food and Drug Administration (FDA) in USA approved a health claim based on the role of soybean protein in reducing the risk of coronary disease. This claim establishes that soybean protein included in a diet low in saturated fat and cholesterol may reduce the risk of coronary disease (FDA, 1999 and Henkel, 2000).

Soybean contains 36 - 40% protein, 18-20% oil, 13-17% soluble carbohydrates, 13-17% Dietary fibres, 8 to 10% moisture. Soybeans are also good sources of calcium, iron, zinc, phosphate, magnesium and vitamin B. It can supply much needed protein to human diet because it contains above 40 % protein of superior quality and all the essential amino acids particularly glycin, tryptophan and lysine. Soybean oil is rich in polyunsaturated fatty acids and contains no cholesterol (Garcia *et al.,* 1997).

There are two ways to extract the oil out of soy, mechanical expelling and solvent extraction. Hexane extraction is the most common industry practice. However, this method requires a lot of capital investment and it can be prone to explosions. Mechanical expelling followed dry extrusion is a more cost-effective way to extract oil and it is safer than hexane extraction. It is also chemical free and requires low capital investment and low operation costs (Riaz, 2001).

Soy protein isolate is soy protein with highest content of protein; it is made from de-oiled soy meal by removing most of the fats and carbohydrates, yielding a product with 90 % protein. Soy protein isolate is a complete vegetable protein. It contains all essential amino acids for growth and it is equal in quality to the protein in meat, milk and eggs. On other hand, it has very low fat content. Soy Protein Isolate may reduce risk of coronary heart diseases. Isolates have specific functional properties that enable them to modify the physical properties of food products. Soy isolates are characterized by certain functional properties: solubility, gelation, emulsification, dispensability, viscosity, and retort stability (Tsen *et al.,* 1973 and Hooda and Jood, 2005).

METHODOLOGY

Raw Materials :

De-oiled soy meal procured from Lakshmi Oil Mill, Aurangabad. Wheat flour, Granulated cane sugar, Packaging Materials like Aluminum foil, Low density polyethylene bags, Other ingredients used in cookies preparation *viz.,* Fat, Baking powder, Ammonium bi carbonate, Sodium bi carbonate, and Glucose etc. were procured from local market of Aurangabad.

Preparation of soy protein isolate :

The soybean seed was de hulled and formed into the split seeds and hulls. The formed split seeds were powdered in to the blender to prepare the flour which was then with water and at pH 8.5 centrifuged at 8000 rpm for 20 min, after centrifugation the residue formed was discarded and again the sample was dialyzed against the distilled water at 5^0C for 24 hrs. Finally the pH adjusted to 4.5 and the sample was centrifuged at 5000 rpm for

20 min and then it was sundried and was prepared according to following flow sheet.

Preparation of composite flour :

Composite flour utilized in the preparation of cookies was prepared by the blending appropriate proportion of Soy Protein Isolate with Refined Wheat Flour as under.

Table A : Preparation of composite flours

Sr. No.	Treatments	Quantity
1.	$T_{1(c)}$	100% RWF + 0 % SPI
2.	T_2	95% RWF + 10 % SPI
3.	T_3	90% RWF + 15 % SPI
4.	T_4	85% RWF + 20 % SPI
5.	T_5	80% RWF + 25 % SPI

Recipe for soy protein isolate and refined wheat flour cookies :

The soy protein isolate and refined wheat flour cookies were prepared using the basic formula of Gaines and Tsen (1980) as under.

Sr. No.	Ingredients	Quantity (g)
1.	Flour	100
2.	Sugar	33
3.	Shortenings	34
4.	Salt	01
5.	Glucose	01
6.	Sodium bi-carbonate	0.27
7.	Ammonium bi-carbonate	0.20
8.	Water	As per requirement

Mixing of sugar and vegetable fat
↓
Creaming of vegetable fat and sugar
↓
Addition of composite flour (RWF and SPI at different ratio)
↓
Addition of baking powder and water
↓
Formation of dough with continuous kneading
↓
Rolling
↓
Cutting
↓
Baking 175^0C (15 min)
↓
Cooling
↓
Packaging and storage

Fig. A : Flow-chart for formulation of cookies

OBSERVATIONS AND ASSESSMENT

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Proximate composition of De-oiled soy meal :

The present investigation began with the proximate analysis of defatted oil meal and the obtained results were depicted in Table 1.

It could be observed from the Table 1 that defatted soy meal found to contain 56.5% of crude protein. The moisture content of sample was found to be 9.20% while the traces of fat remained in the sample with the mare value of 1.1 %. The Ash content of sample was found to be 6.3%. High protein content of sample justifies its suitability as a raw material for preparation of Soy Protein Isolate.

Table 1 : Proximate composition of De-oiled soy meal

Sr. No.	Parameters	Results (%)
1.	Moisture	9.20
2.	Ash	6.3
3.	Crude fibres	2.6
4.	Carbohydrates	24.12
5.	Crude proteins	56.5
6.	Crude fat	1.1

Composition of soy protein isolate and refined wheat flour :

The data related to composition of refined wheat flour was determined and presented in Table 2. Results showed that refined wheat flour contains 72.25% carbohydrates, 8.15% protein, and 1.98% fat the other factors estimated were found to be 11.38%, 1.84%, 2.17% of moisture, ash and crude fibres, respectively.

The proximate composition of obtained soy protein isolate was determined and presented in Table 2. It was interesting to note that successful extraction of soy protein isolate was carried out which contained 84.5 % of protein. The carbohydrate, fat, crude fibre and ash content of Soy Protein Isolate were found to be 9.71, 0.43, 1.76 and 0.73 %, respectively. The proximate composition of SPI describes the suitability of adopted method. On the basis of obtained data pertaining to SPI, it could be stated that defatted soy meal was found to be suitable for the extraction of soy protein isolate.

Table 2 : Chemical composition of soy protein isolate and refined wheat flour

Particulars (%)	Refined wheat flour	Soy protein isolate
Moisture	11.38	2.98
Ash	1.84	0.73
Crude fibre	2.17	1.76
Carbohydrates	72.25	9.71
Protein	8.15	84.5
Fat	1.98	0.43

Physical parameters of SPI fortified cookies :

Physical analysis of soy protein isolate cookies was important from both consumers as well as manufactures point of view and it was desirable that cookies should retain their shape during baking. Soy Protein Isolate and wheat flour cookies along with control were analyzed for physical characteristics including weight, diameter, thickness, and spread factor and results were presented in Table 3.

It was evident from Table 3 that weight of the cookies decreased progressively from (10.43 to 10.36 g) with increasing level of Soy Protein Isolate flour supplementation. The control was having a higher weight (T_1) as compared to 20% soy protein isolate (T_5).

The results elucidated that cookies with 100% wheat flour (T_1) exhibit minimum diameter 4.14 cm while the maximum diameter 4.25 was observed in cookies containing 20% soy protein isolate. Other samples like T_2, T_3, and T_4 showed the results pertaining to increasing trend with proportionate increase of soy protein isolate.

The results pertaining to thickness of the cookies revealed decreasing trend with proportionate increase of soy protein isolate flour in the composite flour. The cookies with 0% Soy Protein Isolate exhibited maximum thickness of 0.90 cm, while minimum thickness *i.e.* 0.85 was observed in cookies with 20% soy protein isolate.

Further it can be revealed from the Table 3 that there was an increasing trend in the spread ratio of cookies prepared from different treatments ranged from 50 to 54.23. Maximum spread factor was observed in cookies with 20% soy protein isolate *i.e.* 54.23 where as a minimum spread factor was observed in cookies with 0% Soy Protein Isolate *i.e.* 50.17.

Maximum top grain was found in cookies with 20% soy protein isolate and that was undesirable. In sample T_1 the top grain was rarely found while in samples T_2 and T_3 the top grain was acceptable but in sample T_4 the top grain was good as compared to all other samples.

Chemical composition of SPI fortified cookies :

The results of the proximate composition of the cookies containing different levels of wheat and Soy Protein Isolate flour are presented in Table 4.

Lesser the moisture content of cookies better its storage stability, here moisture content increase from 2.98 to 4.58 with increase in soy protein isolate in the composite cookies because soy protein isolate absorb the moisture in the food quickly. The results showed that sample T_1 showed lowest moisture 2.98% and sample T_5 shows 4.58% showed highest moisture 4.58% and other samples that were T_2, T_3 and T_4 shows, respectively 3.21%, 3.76% and 4.01% moisture.

Ash content varied significantly from 0.70 to 1.74% in soy protein isolate fortified cookies. High ash content (1.74%) observed in cookies prepared with 20% soy

Table 3 : Physical parameters of SPI fortified cookies

Cookies samples	Weight (g)	Diameter (cm)	Thickness (cm)	Spread factor	Top grain
$T_{1(c)}$	10.43	4.14	0.90	50.17	Rare
T_2	10.40	4.16	0.88	51.20	Acceptable
T_3	10.39	4.19	0.87	52.00	Acceptable
T_4	10.38	4.21	0.86	53.71	Good
T_5	10.36	4.25	0.85	54.23	Not acceptable

Table 4 : Composition of cookies prepared with different ratio of soy protein isolate

Cookies samples	Moisture (%)	Ash (%)	Crude fibres (%)	Carbohydrates (%)	Protein (%)	Fat (%)
$T_{1(c)}$	2.98	0.70	1.42	67.40	5.36	21.14
T_2	3.21	0.90	1.20	63.80	9.34	20.96
T_3	3.76	1.14	1.23	61.05	11.75	20.71
T_4	4.01	1.37	1.17	59.18	13.61	20.63
T_5	4.58	1.74	1.16	56.38	15.68	20.44

protein isolate *i.e.* T_5 and lowest ash content was in T_1 that contains 100% wheat flour and remaining samples namely T_2, T_3, T_4 contains 0.90, 1.14 and 1.37% ash.

The crude fibre content in the soy protein isolate was insignificant. The sample T_1, T_2, T_3, T_4, and T_5, respectively contains 1.42, 1.20, 1.23, 1.17, and 1.16% of the crude fibres.

The results showed that the content of the carbohydrates in the cookies decreases with increasing concentration of the soy protein isolate. The sample with 100% wheat flour *i.e.* T_1 contains highest level of carbohydrates 67.40% and T_5 contains 56.38% carbohydrates other samples T_2, T_3, T_4 contains 63.80, 61.05 and 59.18% carbohydrates.

Addition of the soy protein isolate in composite cookies showed a significant effect on protein content of the final product. There was progressive increase in the protein content from 5.36 to 15.68%. Cookies with 20% soy protein isolate (T_5) contains highest protein *i.e.* 15.68 % followed by T_4 that contains 13.64% protein, T_3 that contains 11.75% protein, sample T_2 contains 9.34% protein and sample T_1 that contains lowest content of protein *i.e.* 5.36%.

The fat content of soy protein isolate cookies explicated significant difference with varying levels of soy protein isolate powder ranged from 21.14 to 20.44%. High fat content was observed in cookies with 100% wheat flour (T_1) and low Fat content was observed T_5 sample. Decrease in the fat content in the soy protein isolate fortified cookies may be due to low fat content of soy protein isolate.

Sensorial quality characteristics of SPI fortified cookies :

The cookies were prepared using soy protein isolate flour at different levels ranging from 0 to 20 %. The prepared cookies were evaluated for their quality and sensory acceptability using 9 point hedonic scale. The cookies were evaluated with respect to colour, flavour, taste, texture, appearance, overall acceptability of the final product.

The sensory score was presented in Table 5. It can be revealed that there was increase in sensory score with addition of soy protein isolate in the product but only upto certain level. The over utilization (20% and more) of soy protein isolate flour may produces undesirable top grain, undesirable flavour and also decrease in overall acceptability.

Control sample *i.e.* T_1 showed 7.8 *i.e.* highest range of colour while sample T_5 showed lowest value for colour.

There was a progressive increase in improvement of flavour from T_1 to T_4 but there was decrease in value

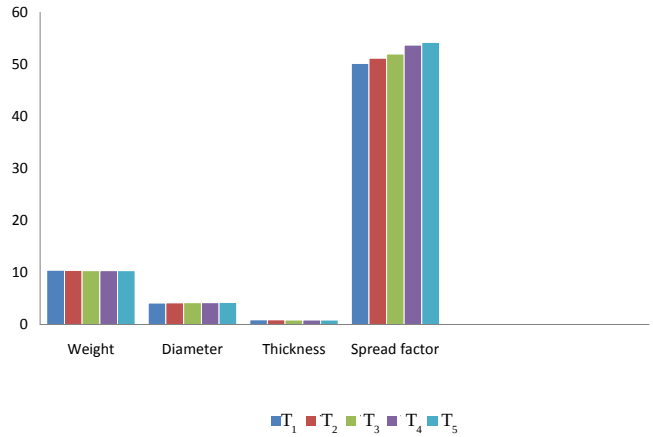

Fig. 1 : Physical properties of SPI fortified cookies

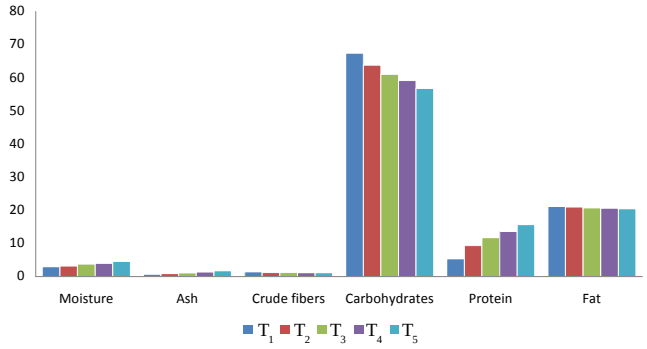

Fig. 2 : Chemical composition of SPI fortified cookies

Table 5 : Sensory quality of SPI fortified cookies

Cookies samples	Blend ratio	Colour	Flavour	Taste	Texture	Appearance	Overall acceptability
$T_{1©}$	00:100	7.8	7.7	08	8.3	8.2	8.1
T_2	05:95	7.3	7.8	7.5	7.6	7.6	7.5
T_3	10:90	7.6	7.8	7.8	8.0	08	7.9
T_4	15:85	7.5	7.9	7.9	8.1	8.1	8.2
T_5	20:80	6.9	7.0	7.2	6.8	7.2	7.0

for flavour for T_5 that may because increasing level of the Soy Protein Isolate was only suitable upto certain level.

The average score for taste was progressively improved from sample T_2 to T_4 where the control sample T_1 showed highest value and sample T_5 showed lowest value for taste.

Similarly as the taste the value of textural progressively improved from sample T_2 to T_4 where T_1 showed highest value for texture *i.e.* 8.3 and T_5 showed lowest value *i.e.* 6.8.

The present investigation control sample showed highest average score for appearance *i.e.* 8.2 and sample T_5 showed lowest value for appearance *i.e.* 7.2.

The overall acceptability of the sample T_4 was highest as compared to other samples and that was same as that of control sample.

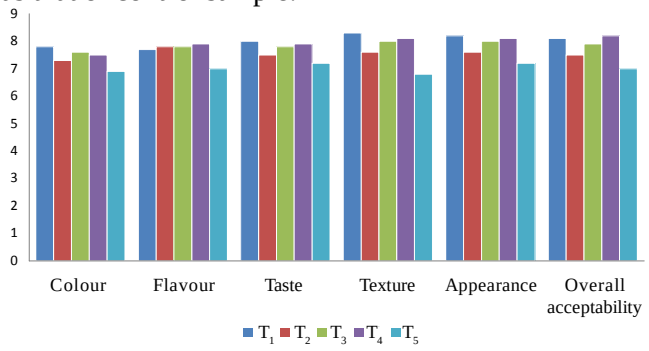

Fig. 3 : Sensory analysis of SPI fortified cookies

Conclusion :

As a result of preliminary trials, it was found that not more than 20% of SPI could be used in preparation of composite flour as further increase in SPI concentration resulted in drastic reduction of overall acceptability.

Therefore cookies were prepared with incorporation of soy protein isolate from 0% [T_1(c)], 5% [T_2], 10% [T_3], 15% [T_4], 20% [T_5] and analyzed for their physical, chemical and organoleptic evaluation. Sample T_4 with 15% incorporation found to be superior with respect to all the aspects. Further increase in the Soy Protein Isolate level will reduce overall acceptability of the product.

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