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Development of partially defatted soy flour and *dhal*

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Abstract

Defatted soy flour is a common form in which soybeans can be incorporated in various indigenous food preparations. The procedure for defatting soy *dhal* and flour has been standardized in the present investigation. Soy flour was soaked in petroleum ether and chloroform:methanol (1:15) for 12 h. For extraction of fat from soy *dhal*, hexane and petroleum ether (1:15) were used. In addition, soy *dhal* was subjected to processing treatments such as pressing, steaming and soaking. The decrease in fat content was significantly ($P < 0.05$) higher when soy flour was treated with petroleum ether. Soaking soy *dhal* in hexane (24 h) followed by shaking for 4 h resulted in maximum reduction in fat content of soy *dhal*. Processing treatments significantly decreased the fat content by 27.52–47.39% compared to the control.

1. Introduction

Legume seeds represent the most abundant source of protein. Two-thirds of the world's population do not get enough food. Protein-energy malnutrition is common in children and results in high morbidity, mortality and intellectual dwarfing of children. The staple food of Indian families is primarily based on cereals, millets and a small proportion of legumes. Rich sources of proteins, i.e., fish, meat, egg and milk, are out of reach of people, as they are expensive. Hence, considering the rising price of animal foods, there is a strong need for natural and economical protein foods from plant sources which an average income family can afford as part of its daily meal. Although, pulses are good sources of plant protein, their availability is progressively decreasing, due to stagnation in production and increase in population (Swaminathan, 1985). Soybean can provide the answer. It possesses several advantages over other protein sources because of low cost-high availability, high nutritional value and continued innovative food product development.

Soybean, being a rich source of protein and fat, seems to be the right substitute for solving the problem of protein-energy malnutrition. Soybean has been used as a food for a long time, but only in this century, has it been subjected to a variety of processing technologies. It is a fairly new crop for Indian consumers and few resources have been directed toward enhancing utilization of soybean in the daily diets of people in the country. Soybeans can be processed into various products, namely, oil, flours, protein concentrates and isolates and other fermented products. There has been a considerable interest in defatted soybeans, due to their high protein value and increased shelf life, resulting from minimization of oil rancidity (Bongirwar, 1977). Since the literature regarding defatting of soy *dhal* is limited, the present study was undertaken.

2. Materials and methods

2.1. General

Soybean (variety PK 416) was procured from the Department of Plant Breeding, College of Agriculture, CCSHAU, Hisar. Soybeans were cleaned of extraneous matter. Before processing and nutritional analysis, cleaned soybeans were graded, using a seed grader in the

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Department of Agricultural Processing & Energy, College of Agricultural Engineering and Technology, CCS-HAU, Hisar. Fat content in raw and treated soybean was analysed using a standard method (AOAC, 1995).

2.2. Standardization of procedure for defatting of soy flour

2.2.1. Preparation of soy dhal or soy splits and soy flour

Raw soybean seeds were blanched for 15 min and husk was removed manually by manual rubbing. Splits obtained were dried at 65 °C in an oven. Dried splits were ground to flour.

2.2.2. Treatment Ia

Ten grams of soy flour was soaked overnight in 100 ml of different organic solvents, i.e., petroleum ether and chloroform methanol (2:1) solution. Next day, solvent was decanted and flour was again dried in an oven at 65 °C. Fat was estimated in the sample by the standard method (AOAC, 1995).

2.2.3. Treatment Ib

Raw soybean seeds were soaked overnight in water. Next day, the water was discarded and seeds were blanched for 15 min in boiling water. Splits were separated, dried in an oven and ground to flour. Rest of the procedure was the same as given in Treatment Ia. When soy *dhal* is soaked in water prior to soaking in solvents, water-soluble minerals will be leached out and reduction in the fat content is adversely affected.

2.3. Standardization of procedure for defatting of soy dhal

2.3.1. General

Different treatments were given to soy *dhal* using various solvents so that maximum amount of fat can be extracted.

2.3.2. Treatment II

Soy *dhal* after blanching was dipped overnight (12 h) in two different solvents, i.e., petroleum ether and hexane separately. Next day, the samples were kept on shaker for 4 h. After that, solvent was decanted, splits were dried in an oven at 65 °C, ground to flour and fat in flour was estimated using standard methods (AOAC, 1995).

2.3.3. Treatment III

Soy splits were dipped in petroleum ether and hexane separately each for 24 h. Each sample was kept on shaker for 4, 6 and 8 h. The solvent was decanted and splits were dried in an oven at 65 °C. After drying, soy splits/*dhal* were ground to fine powder and fat was estimated using a Soxhlet apparatus.

2.3.4. Treatment IV

In this treatment, soy splits were dipped in petroleum ether and hexane separately for 48 h followed by shaking for 4, 6 and 8 h. The solvent was decanted and splits were dried in an oven and ground to fine powder. Fat content was estimated using a Soxhlet apparatus.

2.4. Standardization of different processing treatments for defatting of soy dhal

2.4.1. General

Different processing treatments were applied to soy *dhal* to extract the maximum fat.

2.4.2. Processing I

Soy splits were pressed using a pestle mortar and dipped overnight in petroleum ether and hexane, separately. Decanting was done and splits were dried in an oven at 65 °C, ground to fine powder and used for fat estimation using a Soxhlet apparatus (Fig. 1).

2.4.3. Processing II

Soybean splits were steamed for 10 min and dipped overnight in hexane and petroleum ether, separately. Next day, the soaking solutions were decanted, splits were dried in an oven and ground to a fine powder. Fat

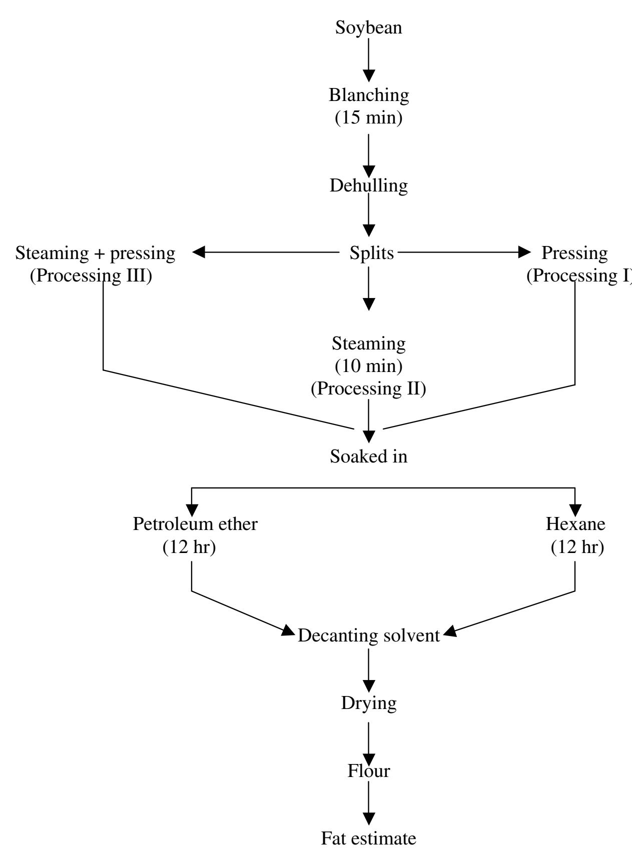

Fig. 1. Flow chart of various processing treatments given to soy *dhal*.

content in the flour was estimated using standard method of AOAC (1995) (Fig. 1).

2.4.4. Processing III

Soy splits were steamed for 10 min, pressed using a pestle mortar and dipped overnight in petroleum ether and hexane, separately. Next day, the soaking solutions were decanted, splits were dried in an oven and ground to a fine powder. Fat content in the flour was estimated using a standard method of AOAC (1995) (Fig. 1).

3. Results and discussion

3.1. Fat content in soy flour after treatment with different organic solvents

The results in Table 1 show the fat content of raw soy flour and soy flour treated with various organic solvents. Raw soy flour had 23.4% fat. The present findings corroborate with those reported by Kapoor, Kushwah, and Datta (1975) who found 18.45–27.98% fat in 12 varieties of soybean. Similar findings have been observed by Seralathan, Thirumaran, and Neelakandan (1989) who analysed 13 varieties of soybean and reported 24.52–28.99% fat.

When soy flour was soaked in organic solvents a significant ($P < 0.05$) reduction in fat content was observed and it ranged from 59.27% to 77.44%. Soaking raw soy flour in petroleum ether and chloroform:methanol for 12 h (as given in Treatment Ia) resulted in a significant ($P < 0.05$) decrease in fat content, i.e., 77.44% and 63.67%, respectively, as compared to untreated soy flour (control). The fat content of soy flour was 5.28% when it was treated with petroleum ether, whereas chloroform:methanol-treated soy flour had 8.50% fat.

However, in Treatment Ib, raw soybean was soaked in water for 12 h, soy flour was prepared and the rest of the procedure was the same as given in Treatment Ia. The results showed that fat content of water-soaked soy *dhal*, treated with petroleum ether and chloroform:methanol, was 6.45% and 9.53%, respectively. A significant ($P < 0.05$) reduction, up to 72.43% in fat content of soy *dhal*, was observed in this treatment. However, additional soaking in water prior to soaking in petroleum ether or chloroform:methanol had no extra advantage in fat extraction of soy flour. The per cent reduction in fat content was significantly greater in treatment Ia than in treatment Ib.

Thus, it can be inferred from Table 1 that soy flour can be defatted by 77.44%, by soaking soy flour in petroleum ether for 12 h.

3.2. Fat content of soy dhal after treatment with different organic solvents

Two organic solvents namely, hexane and petroleum ether were used to extract fat from soy *dhal*. The results in Table 2 depict the fat contents and the per cent

Table 1
Fat contents of soy flour after treatment with different organic solvents

Treatment	Control (raw soy flour)	Soy flour soaked in petroleum ether	Soy flour soaked in chloroform:methanol	CD at 5%
Soaking soy flour in petroleum ether/ chloroform:methanol (2:1) for 12 h (Ia)	23.4 ± 0.05	5.28 ± 0.02 (77.4)	8.50 ± 0.03 (63.67)	0.15
Soybean soaking in water (12 h), followed by soaking soy flour in petroleum ether/ chloroform:methanol for 12 h (Ib)	23.4 ± 0.05	6.45 ± 0.04 (72.4)	9.53 ± 0.02 (59.27)	0.15

Figures in parentheses indicate per cent decrease over control value.
Values are means ± SD of three replicates.

Table 2
Fat contents of soy *dhal* after treatment with different organic solvents

Treatment	Control (raw soy flour)	Soy flour soaked in hexane	Soy flour soaked in petroleum ether	CD at 5%
Soaking soy *dhal* (12 h) and shaking (4 h) (II)	23.40 ± 0.05	21.84 ± 0.06 (6.67)	22.27 ± 0.04 (4.83)	0.16
Soaking soy *dhal* (24 h) and shaking (4 h) (IIIa)	23.40 ± 0.05	21.17 ± 0.03 (9.53)	21.35 ± 0.03 (8.76)	0.13
Soaking soy *dhal* (24 h) and shaking (6 h) (IIIb)	23.40 ± 0.05	21.21 ± 0.02 (9.36)	21.51 ± 0.03 (8.08)	0.18
Soaking soy *dhal* (24 h) and shaking (8 h) (IIIc)	23.40 ± 0.05	21.18 ± 0.06 (9.49)	21.40 ± 0.02 (8.55)	0.39
Soaking soy *dhal* (48 h) and shaking (4 h) (IVa)	23.40 ± 0.05	21.31 ± 0.06 (8.93)	21.41 ± 0.03 (8.50)	0.10
Soaking soy *dhal* (48 h) and shaking (6 h) (IVb)	23.40 ± 0.05	21.33 ± 0.06 (8.85)	21.43 ± 0.03 (8.42)	0.26
Soaking soy *dhal* (48 h) and shaking (8 h) (IVc)	23.40 ± 0.05	21.32 ± 0.03 (8.88)	21.44 ± 0.05 (8.38)	0.11
CD ($P < 0.05$)		0.11	0.08	

Figures in parentheses indicate per cent decrease over control value.
Values are means ± SD of three replicates.

reductions in fat contents of treated soy *dhal*. Hexane and petroleum ether significantly ($P < 0.05$) decreased the fat content of soy *dhal*. The per cent reduction in fat content with different treatments (Table 2) ranged from 4.83% to 9.53% compared to the control.

In treatment II, soy splits were soaked in hexane and petroleum ether for 12 h, followed by shaking for 4 h. Results revealed that treated *dhal* contained 21.84% and 22.27% fat, respectively (Table 2), which was significantly ($P < 0.05$) lower than the unprocessed control (raw soybeans). The reduction in fat content was greater in soy *dhal* treated with hexane than in soy *dhal* treated with petroleum ether.

In treatment III (Table 2), the soaking period of soy *dhal* in hexane and petroleum ether was 24 h, followed by shaking for 4 (Treatment IIIa), 6 (Treatment IIIb) and 8 h (Treatment IIIc). The results revealed that in treatment IIIa, the per cent reductions in fat content of hexane- and petroleum ether-treated soy *dhal* were 9.53% and 8.76%, respectively, compared to the unprocessed control. The decrease in fat content was significant ($P < 0.05$) in both the treatments when compared to the control, however, the per cent reduction was greater in the case of soy *dhal* treated with hexane. In treatment IIIb, the shaking time of treated soy *dhal* was 6 h and results depicted that fat contents of hexane- and petroleum ether-treated soy *dhal* were 22.21% and 21.51%, respectively (Table 2), which were 9.36% and 8.08% lower as compared to unprocessed control. Further, when soy *dhal* soaked in hexane and ether was shaken for 8 h, the fat content decreased significantly ($P < 0.05$), by 9.49% and 8.55%, respectively.

Thus, it can be concluded that both hexane and petroleum ether were effective in lowering the fat content of soy *dhal* ($P < 0.05$). However, maximum reduction in fat content was found in soy *dhal* treated with hexane (as compared to petroleum ether-treated soy *dhal*).

In treatment IV, soy *dhal* was soaked in hexane and petroleum ether for 48 h, followed by shaking for 4 (Treatment IVa), 6 (Treatment IVb) and 8 h (Treatment IVc). There was not much difference in the fat contents of soy *dhal* treated with petroleum ether (21.31%) and hexane (21.41%) and shaken for 4 h (Treatment IVa) but fat was significantly ($P < 0.05$) less than that of raw soybean. Further, when shaking time was increased to 6–8 h (Treatment IVb, IVc), the fat content of soy *dhal* was reduced significantly; however, the per cent reduction in fat content was less than that observed in Treatment IVa.

Thus, soy *dhal* can be defatted by 4.83–9.53% using various processing treatments. The reduction in fat content of soy *dhal* was maximum when it was soaked in hexane for 24 h, followed by shaking for 4 h. Further increases in soaking time and shaking time had no significant effect on reduction in fat content of soy *dhal*. Das, Tewary, Bandyopadhyaya, and Dhote (1987) reported that soy splits, when soaked in hexane containing 2% of dry sodium bicarbonate for 4 h, showed 1.5% reduction of oil.

3.3. *Effect of various processings on fat content of soy dhal*

Table 3 shows the fat content of soy *dhal* processed using pressing and steaming techniques, followed by soaking in hexane or petroleum ether. The fat content of soy *dhal*, when pressed and soaked in hexane and petroleum ether for 12 h (Processing I), decreased significantly ($P < 0.05$) by 35.38% and 32.31% when compared to that of raw soybean.

In processing II, soy *dhal* was steamed, followed by soaking in hexane and petroleum ether for 12 h and it was found that the fat contents were 16.96% and 17.50%, respectively, significantly ($P < 0.05$) lower than that of raw soybeans.

In processing III, according to Table 3, the reduction in oil content was greater in the petroleum ether-treated sample (12.31%) than in the hexane-treated sample (12.55%).

Overall, pressing and steaming, followed by soaking soy *dhal* in hexane and petroleum ether, significantly decreased the fat content by 25.21–47.39%. Thus, it may be concluded that defatted soy flour, produced by the above method, may be used as dietary protein supplement in various products. Soy flour can be defatted by 77%, however, soy *dhal* can be maximally defatted by 9% using different organic solvents. Processing treatments, especially steaming, pressing and soaking in

Table 3
Effect of various processing treatments on fat contents of soy *dhal*

Processing treatments	Control	Soy *dhal* soaked in hexane	Soy *dhal* soaked in petroleum ether	CD at 5%
Soy splits pressed and soaked for 12 h (Processing I)	23.40 ± 0.05	15.12 ± 0.12 (35.38)	15.84 ± 0.38 (32.31)	0.26
Soy splits steamed and soaked for 12 h (Processing II)	23.40 ± 0.05	16.96 ± 0.09 (27.52)	17.50 ± 0.44 (25.21)	0.21
Soy splits steamed, pressed and soaked for 12 h (Processing III)	23.40 ± 0.05	12.55 ± 0.08 (46.37)	12.31 ± 0.57 (47.39)	0.22
CD ($P < 0.05$)		0.32	0.17	

Figures in parentheses indicate per cent decrease over control value.
Values are means ± SD of three replicates.

hexane and petroleum ether, seemed beneficial for maximum extraction of fat from soy *dhal*. Further, there is a need to study whether such defatted soy *dhal* can be used for development of products having consumer acceptability and such work is under progress, and will be reported in future communications.

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