Effect of roasting on comparative physical characteristics of linseed kernels

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Abstract

The changes in physical and optical properties of linseed kernels on roasting were assessed. Physical properties play vital role in quality characterization, selection and in design of handle, transport and process equipment. Twelve popular linseed varieties LC-2023, LC-2063, LC-54, Padmini, Sheela, Shekhar, Sweta, Chambal, Suyog, Himani, Neelam, Surbhi were selected for the present study. Physical properties like as geometrical, gravimetrical, frictional and optical properties of roasted linseeds were compared with raw linseeds. Results indicated that roasting decreased the seed length, width and aspect ratio from 4.89 to 4.69 mm, 2.41 to 2.28 mm and 49.34 to 48.53, respectively while thickness, geometric mean diameter and surface area increased linearly from 0.86 to 1.53 mm, 3.42 to 5.54 mm, 38.78 to 101.84 mm^2, respectively. Thousand seed weight, bulk density, true density and porosity decreased after roasting from 7.55 to 7.38 g, 671.83 to 631.13 kg/m^3, 1093.26 to 841.28 and 38.40 to 25.04 %, respectively. The static coefficient of friction found minor differences and varied in the range of 0.35 to 0.37, 0.33 to 0.36, 0.38 to 0.30, and 0.33 to 0.32 for ply perpendicular, ply parallel, glass and galvanized iron surfaces, respectively. The angle of repose decreased linearly from 20.01^0 to 17.52^0 after roasting of linseed. Colour also changed after roasting as per the result of optical properties.

Keywords: Linseed, physical, frictional, optical, gravimetric property.

Linseed (*Linum usitatissiumum*) belongs to family Linaceae andalso known as flaxseed, alsi and chickna in India. It is one of the most important oilseed crops in the world (Coskuner and Karababa, 2007). Linseed plant is supposed to be the native of India and the eastern Mediterranean. It is grown throughout the world including Canada, China, United States and Ethiopia (FAOSTAT, 2013). India contributes almost 20 percent of the total world production of linseed and also governs the linseed production among Asian countries. Madhya Pradesh, Uttar Pradesh, Maharashtra, Bihar, Rajasthan, West Bengal, Karnataka, Orissa, Andhra Pradesh, and Himachal Pradesh are the major states growing this crop with a total area under cultivation is about 2.5 million hectares. India governs the linseed production of Asian countries and contributes almost 20 percent of the total world production (Sharma and Prasad, 2013).

Linseed is one of the leading vegetable sources of essential fatty acid. As alpha-linolenic acid (ALA), the omega-3 fatty acid, it is present in linseed oil to an extent of 45-50%. It contains 73% polyunsaturated fatty acids, 18% monounsaturated fatty acids and low saturated fatty acids below 9% (Thompson *et al*., 1995). Regular intake of small portions of linseeds in the diet helps to lower total an low density lipoprotein a bad cholesterol. It is found that consumption of linseed increases high density lipoprotein a good cholesterol in the blood (Oomah, 2001). Thus reduces the occurrence of high blood pressure and also found useful in diabetes, asthma and arthritis. Cynogenic glucoside (linustatin, neolinustatin, linamarin and lotaustralin) was also found to be reported in linseed to an extent of 0.1%. Some report says that cyanide may also be present in the linseed but it is to be worth to mention that an adult can detoxify 30-100 mg of cyanide per day. Although presence anti-nutritional compound are reflected but the bodily detoxifying mechanism and the associated merits makes this item a unique functional biomaterial to be used in the preparation of foods. Further, roasting converts linseed safe with the rich source of monounsaturated and omega-3 essential fatty acids (Prasad, 2003). Linseed oil is probably best known for its functional properties in

the production of paints and floor covering (Singh *et al*., 2011).

The physical properties of linseeds and like those of other grains and seeds are essential for the design of equipments, especially for handling, processing and storing the grains. To the best of our knowledge, there is no detailed study regarding the comparison of physical properties of raw and roasted flaxseed. The objective of this study was to investigate some physical properties of linseeds (Raw and Roasted) namely size, volume, shape, surface area, thousand kernels weight, true density, bulk density, porosity, coefficient of friction on the different surface of different materials and angle of repose and optical properties.

Material and method

Raw Material: Twelve major varieties of linseed grown in India, viz. LC-2023, LC-2063, LC-54, Padmini, Sheela, Shekhar, Sweta, Chambal, Suyog, Himani, Neelam, Surbhi were procured from CSAUA&T, Kanpur and PAU, Ludhiana. Kernels of all varieties were subjected to air classifier to remove the dirt, dist, chaffs, lighter particles as well as damaged kernels. All varieties kernels were roasted in a similar temperature time combinations. Linseed kernels were roasted in a metallic roasting pan for 5-10 seconds. The roasted kernels were then cool to room temperature. The physical and optical properties were determined (Prasad *et al*., 2010; Sharma and Prasad, 2013).

Dimensional Properties: The particle size analysis of cleaned raw linseed kernels and roasted linseed kernels was determined through the developed image analysis technique (Prasad *et al.*, 2012).The geometric mean diameter (Dg), surface area (Sα) and aspect ratio (*Ra*) was calculated as described elsewhere (Prasad *et al.*, 2010; Singh and Prasad, 2013).

Gravimetric properties: Thousand seed weight was determined using electronic balance. The bulk density is the ratio of the mass sample of the seeds to its total volume (Gupta and Das, 2000). The true density is defined as the ratio of mass of seed to the solid volume occupied. The seed volume and its true density was determined using liquid displacement technique. Toluene was used in spite of water so as to prevent the absorption during measurement and also to get the benefit of low surface tension of selected solvent**.** The porosity (ε) of bulk seed was computed from the values of true density (ρt) and bulk density (ρb) (Konak *et al*, 2002).

Frictional properties: The coefficient of static friction was determined with respect to four surfaces: plywood parallel, plywood perpendicular, stainless steel, glass. These are common materials used for transportation, storage and handling operations of grains, pulses and seeds construction of storage and drying bins. To determine the angle of repose, a cylinder (50 mm diameter and 60 mm height) was kept vertically on a horizontal galvanized metal floor and filled with the sample. The height of heap above the floor and the diameter of the heap at its base were measured and the angle of repose (θ) was determined. The angle of repose was calculated from the height and diameter of the naturally formed heap of the seeds on a circular plate (Jha, 1999).

Optical properties: Colour Parameters to measure colour, L, a and b values of the flaxseed were determined by color spectrophotometer (Prasad *et al*., 2010, Singh and Prasad, 2013).

Where,

L= degree of lightness to darkness

a= degree of redness to greenness

b=degree of yellowness to blueness

Results and Discussion

Dimensional Properties: The length, width and thickness of the raw linseed varieties varied from 4.35 (var. Surbhi) to 5.58 mm (var. Neelam), 2.10 (var. Surbhi) to 2.86 mm (var. Neelam) and 0.74 (var. LC-2063) to 1.03 mm (var. Neelam), respectively and length, breadth and thickness of the roasted linseed varieties varied from 4.09 (var. Surbhi) to 5.36 (var. Neelam) , 2.02 (var. LC-54) to 2.77 (var. Neelam), 1.36 (var. LC-54) to 1.80 (var. Neelam), respectively (Table 1). It is found that the length and width of linseed decreases on roasting whereas thickness increases. Geometric mean diameter (GMD), surface area and aspect ratio of raw linseed ranged from 2.33 (var. Surbhi) to 5.45 mm (var. Neelam), 17.08 to 93.43 mm and 46.36 (var. LC-54) to 51.85 (var. Chambal), respectively and roasted linseed 4.12 (var. Surbhi) to 8.91 (var. Neelam), 53.27 (var. Surbhi) to 249.36 (var. Neelam) and 44.64 (var. LC-54) to 52.18 (var. Surbhi), respectively. It is further reflected that increase in GMD and surface area whereas the aspect ratio decreases on roasting.

Gravimetric Properties: The true density of raw linseed varieties was in the range of 1,006.00 (var. Neelam) to 1,198.33 (var. Chambal) kg/m^3 and roasted linseed 798.99 (var.LC-2023) to 894.33 (var. Shekhar) kg/m^3 (Table 2). Bulk density of raw linseed was found in the range of 571.31 (var.

Table 1: Dimensional properties of raw and roasted linseed

Variety	Length(mm)		Width(mm)		Thickness(mm)		Aspect ratio		Surface area(mm^2)		GMD (mm)	
	Raw	Roasted	Raw	Roasted	Raw	Roasted	Raw	Roasted	Raw	Roasted	Raw	Roasted
LC-2023	4.61	4.50	2.32	2.22	0.81	1.48	50.47	49.25	25.95	76.69	2.87	4.94
LC-2063	4.68	4.50	2.30	2.19	0.74	1.39	49.14	48.58	22.52	65.63	2.66	4.56
LC-54	4.77	4.52	2.21	2.02	0.88	1.36	46.36	46.64	30.50	54.67	3.10	4.15
Padmini	4.93	4.91	2.49	2.38	0.86	1.54	50.50	48.33	39.25	113.42	3.53	5.99
Sheela	4.96	4.76	2.36	2.23	0.84	1.52	47.66	46.82	33.98	90.62	3.29	5.37
Shekhar	4.96	4.69	2.51	2.44	0.94	1.63	50.66	52.02	48.17	121.99	3.91	6.20
Sweta	4.94	4.79	2.51	2.38	0.84	1.59	50.82	49.68	38.06	114.78	3.48	6.03
Chambal	4.89	4.99	2.53	2.29	0.76	1.52	51.85	45.84	31.64	105.99	3.14	5.79
Suyog	5.37	4.87	2.49	2.27	0.93	1.59	46.43	46.49	54.44	109.95	4.16	5.88
Himani	4.65	4.35	2.27	2.04	0.88	1.55	48.84	46.94	30.31	65.69	3.10	4.57
Neelam	5.58	5.36	2.86	2.77	1.03	1.80	51.17	51.66	93.43	249.33	5.45	8.91
Surbhi	4.35	4.09	2.10	2.13	0.77	1.42	48.22	52.18	17.08	53.27	2.33	4.11

Table 2: Gravimetrical properties of raw and roasted linseed

Variety	Bulk density (kg/m^3)		True density (kg/m^3)		Porosity (%)		1000 Seed wt. (g)	
	Raw	Roasted	Raw	Roasted	Raw	Roasted	Raw	Roasted
LC-2023	711.989	555.132	1056.111	798.988	32.581	30.499	6.097	5.530
LC-2063	670.533	641.603	1103.333	890.556	39.208	27.935	6.523	6.370
LC-54	738.303	710.127	1111.667	845.893	33.565	16.017	6.903	6.267
Padmini	660.000	659.649	1098.333	888.889	39.905	25.735	8.020	7.290
Sheela	571.308	459.135	1099.167	815.972	47.993	43.731	7.503	8.910
Shekhar	761.590	654.970	1077.500	894.333	29.289	26.717	8.557	8.837
Sweta	652.909	691.753	1054.000	804.702	38.041	14.036	8.023	8.397
Chambal	680.533	559.845	1198.333	817.202	43.195	31.432	7.080	7.077
Suyog	676.933	629.444	1091.333	804.345	37.948	21.706	8.997	8.090
Himani	654.297	688.557	1067.500	845.417	38.704	18.509	6.503	5.987
Neelam	659.614	801.318	1006.000	872.667	34.394	8.153	10.967	10.470
Surbhi	624.005	522.043	1155.833	816.429	46.010	36.032	5.420	5.367

Table 3:Frictional properties of raw and roasted linseed

Variety	Coefficient of Friction								Angle of repose (^{0})	
	Ply perpendicular		Ply parallel		Steel		Glass			
	Raw	Roasted	Raw	Roasted	Raw	Roasted	Raw	Roasted	Raw	Roasted
LC-2023	0.34	0.35	0.32	0.35	0.32	0.33	0.38	0.34	18.39	17.80
LC-2063	0.32	0.34	0.30	0.34	0.34	0.34	0.35	0.30	21.75	17.85
LC-54	0.33	0.35	0.30	0.34	0.30	0.30	0.37	0.28	24.45	13.12
Padmini	0.34	0.36	0.32	0.33	0.34	0.33	0.36	0.30	18.41	18.99
Sheela	0.35	0.43	0.37	0.36	0.37	0.32	0.40	0.29	22.31	19.56
Shekhar	0.39	0.36	0.35	0.35	0.35	0.34	0.41	0.27	20.60	17.27
Shweta	0.34	0.41	0.33	0.39	0.33	0.32	0.43	0.31	19.56	20.12
Chambal	0.34	0.37	0.33	0.34	0.33	0.32	0.41	0.28	20.09	15.48
Suyog	0.34	0.38	0.31	0.38	0.34	0.32	0.41	0.31	18.41	15.48
Himani	0.34	0.38	0.33	0.34	0.32	0.31	0.39	0.29	21.73	16.68
Neelam	0.34	0.39	0.32	0.32	0.33	0.31	0.34	0.30	24.40	20.68
Surbhi	0.37	0.35	0.33	0.46	0.32	0.31	0.34	0.29	10.06	17.27

Table 4:Optical properties of raw and roasted linseed

Variety	L		a		b		Colour difference	
	Raw	Roasted	Raw	Roasted	Raw	Roasted	Raw	Roasted
LC-2023	49.367	45.670	9.738	6.337	11.990	8.116	51.727	46.819
LC-2063	49.298	44.253	6.717	5.479	11.707	7.028	51.285	45.142
LC-54	49.531	45.594	10.013	6.516	12.261	8.393	52.001	46.816
Padmini	48.854	46.442	10.647	6.322	12.658	8.347	51.581	47.608
Sheela	49.238	46.88	9.965	6.352	11.649	9.947	51.579	48.351
Shekhar	50.247	45.343	10.127	6.032	11.949	8.711	52.634	46.566
Sweta	47.814	43.115	9.661	5.929	10.557	7.923	49.910	44.237
Chambal	47.364	45.585	9.009	5.678	10.650	8.275	49.377	46.677
Suyog	49.949	45.209	9.738	5.547	12.098	6.998	52.309	46.083
Himani	48.406	43.653	9.501	5.773	10.754	6.970	50.489	44.581
Neelam	48.470	46.604	9.500	5.957	10.930	8.276	50.589	47.707
Surbhi	63.916	51.262	10.738	10.244	24.772	16.005	69.385	54.674

Sheela) to 761.59 (var. Shekhar) kg/m^3 and roasted linseed 459.14 (var. Sheela) to 801.32 (var. Neelam) kg/m^3. The porosity of the raw linseed ranged from 29.29% (var. Shekhar) to 47.99% (var. Sheela) and roasted linseed 8.15% (var. Neelam) to 43.73% (var. Sheela). The 1000-seed weight of raw linseed was in the range of 5.42 to 10.97 g, where the least value was shown by Surbhi variety and highest value was recorded for Neelam variety of flaxseed and roasted linseed were in the range of 5.37 (var. Surbhi) to 10.47 g (var. Neelam). The 1000 seed weight of linseed kernels were decreased after roasting as the removal of moisture from the kernel due to thermal treatment.

Frictional Properties: The static coefficient of friction was studied on four different surfaces ply perpendicular; ply parallel, galvanized iron and glass. It ranged from 0.32 to 0.39, 0.30 to 0.37, 0.30 to 0.36 and 0.34 to 0.43, respectively for raw linseed (Table 3). LC-2063 and LC-54 varieties shows least coefficient of friction on ply parallel and steel surface and variety Sweta shows highest coefficient friction on glass surface. Same as that roasted linseed varieties coefficient of friction studied on different four surfaces ply perpendicular, ply parallel, galvanized iron and glass. It ranged 0.34 to 0.43, 0.32 to 0.46, 0.30 to 0.34 and 0.27 to 0.34, respectively (Table 3). Shekhar and LC-54 shows least coefficient of friction on glass and steel surface and Surbhi and Sheela shows highest coefficient of friction on ply parallel and ply perpendicular surface. The angle of repose of the studied raw linseed varieties ranged from 10.06° to 24.45° (Table 3). Raw linseed var. Surbhi shows least value and LC-54 shows highest value. Similarly roasted linseed variety ranged in 13.12^0 (LC-54) to 20.68^0 (Neelam).

Optical properties: The lowest and highest values for lightness "L" were found as 49.949 (Suyog) to 63.916 (Surbhi) (Table 4). L shows degree of lightness to darkness in which Surbhi variety shows highest value of lightness and Suyog shows lowest value respectively. Similarly, "a" shows degree of redness to greenness in which var. LC-2063 (6.717) shows lowest value of redness and var. Surbhi (10.738) shows highest value of redness and degree of yellowness to greenness shows by "b" value in which var. sweta shows lowest value 10.557 and var. Surbhi shows highest value 24.772 in raw linseed. Comparatively after roasting of linseed change in value of "L", "a" and "b" observed. Var. Sweta (43.115) shows lowest value of lightness and var. Surbhi (51.262) shows highest value. LC-2063 (5.479) shows lowest value of redness and var. Surbhi (10.224) shows highest value of redness. Himani shows lowest value 6.970 and var. Surbhi shows highest value 16.005 of "b" in roasted linseed.

Conclusion

The variations found in the studied physical and optical properties on roasting of raw linseed may play a vital role for the development of storage, conveying, processing, handling and transportation equipments. Moreover, the optical properties may also be applied in order to maintain the quality of roasted linseed in an automated process based on the thermal treatments.

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