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Influence of germination temperature on oil content and fatty acid composition of soy sprouts

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Oil content and fatty acid composition were studied in the seedlings of 'Samrat' and 'JS335' soybean genotypes germinated for different periods at 25 and 35°C. Oil content decreased faster under 35°C in both the genotypes. No significant changes in fatty acid composition of the seedlings till 5th day or germination in both genotypes at both the temperatures were observed. A lower level of oleic acid content as compared to mature seeds was observed in 6-day old seedlings at 25°C than at 35°C in both the genotypes. Among essential fatty acids, an increase in linoleic acid in 6-day old seedling at 25°C in both the genotypes was observed, however, no significant differences were observed for linolenic acid (omega-3 fatty acid) in seedlings upto 6th day in both the genotypes at both the germinating temperatures.

Keywords: Soybean sprouts, Germination, Temperature, Oil, Fatty acids

Soybeans, like many other legume [redacted], are consumed as sprouts after germinating for different periods. Soy sprouts have an advantage over other legume sprouts for not only being higher in protein content but also for containing neutraceutical ingredients, like in mature seeds, that reduce the risk of a range of hazardous diseases like breast cancer, uterus cancer, atheroscelerosis, and osteoporosis (Messina 1997). As compared to mature seeds, soy sprouts have reduced anti nutritional factors like oligosaccharides, trypsin inhibitor, and lipoxygenases (Jimnez et al 1985, Vineet Kumar et al 2006). In comparison with other cereal and legume sprouts, soy sprout is rich in polyunsaturated fatty acids, also known as essential fatty acids, especially α-linolenic acid (C18:3), and omega-3 fatty acid. Though, omega–3 fatty acids are the [redacted]nary components in the phospholipid bilayer in the membrane cells, brain, retina, nerve tissues, however, their anti-thrombotic, anti-inflammatory, anti-immunoreactive properties mark their significance in preventing atheroscelerosis, arthritis, cancer, allergies and other chronic diseases (Van Schacky et al 1999, Sugano 2001, Simpoulos 2001, Jho et al 2004). However, the presence of higher oil content as compared to other legume sprouts is a discouraging factor among people seeking low–fat diet. Fats are degraded during germination process as indicated in several studies (Mostafa et al 1987, Bau et al 1997). However, the information on varying temperature during the development of sprouts on changes in oil content and fatty acid composition is lacking. Therefore, the present investigation was undertaken with a view to observe changes in oil content and fatty acid composition in germinating genotypes at two temperatures.

Seeds of 2 popular soybean genotypes 'Samrat' and 'JS335' were germinated at 25 and 35°C for 6 days in a seed germinator, (Indosaw), in dark. The germination was carried out in dark because light causes sprouts to develop roots and turn green, both of which are undesirable traits for bean sprouts. During germination, after every 24 h, 100 seedlings were taken in triplicate and their fresh weights were recorded. Subsequently, they were allowed to dry in a seed drier at 37°C till they became completely moisture free. Moisture percentage was calculated by subtracting dry weight from fresh weight. Dried seedlings were ground in a metallic pestle and mortar. Soy flour obtained was extracted with petroleum ether (b.p. 60-80°C) in a Soxhlet unit for 7 h. Percent oil content was calculated by gravimetric method. Oil obtained was transesterified in methanol with 1N sodium methoxide as catalyst following the method of Luddy et al (1968). Fatty acid methyl esters (FAME) were separated and analyzed in gas chromatograph (Shimadzu GC 17A), using polyethylene glycol packed SGE BP20 capillary column, with length and internal diameter of 30 m and 0.32 mm respectively. Oven temperature of gas liquid chromatography was programmed at 140°C for 3.6 min, subsequently increased to 170°C at the rate of 13.5°C/min and maintained for 3.8 min and finally increased to 182°C at the rate of 5°C/min for best resolution of methyl esters. The temperatures of flame ionization detector (FID) and injector were maintained at 240°C. Nitrogen, the carrier gas used, was maintained at a flow rate of 15 ml/min. Peaks for individual fatty acid methyl esters were identified by comparing the retention times with those of standard methyl esters (Sigma-Aldrich, India).

Fresh weight of seedlings increased continuously with germination period in both the genotypes at both the temperatures (Table 1). Ratio between maximum fresh weight of seedlings to mature seeds in 'Samrat' was 3.46:1 and 4.22:1 at germination temperature of 25 and 35°C respectively. 'JS335' exhibited ratio of 3.53:1 and 4.46:1 between maximum fresh weight of seedlings to mature seeds at 25 and 35°C, respectively. Moisture content increased in germinating soybean seeds in both the genotypes under both the temperatures. Higher fresh weight for seedlings at 35°C was mainly due to the higher moisture percentage rather than dry matter. Under both the germinating temperatures, oil content declined continuously till 120 h (5th day) in 'Samrat' and till 144 h (6th day) in 'JS335' (Table 1). Furthermore, percent decline in oil content was higher in 'JS335' as compared to 'Samrat' under both the germination temperatures and the rate of oil decline was faster at 35°C as compared to 25°C in both the genotypes.

After a germination period of 6 days (144 h) at 25°C, 'Samrat' and 'JS335' showed a percent oil decline to the magnitude of 33.8 and 40.0, respectively while germination for the same period at 35°C led to a percent decline of 43.4 in 'Samrat' and 47.0 in 'JS335'. Maximum decline in

Table1. Changes in (%) moisture, oil content (dry weight basis) and fatty acid composition during germination at different temperatures

Genotype	Germination	Moisture		Oil		C16:0		C18:0		C18:1		C18:2		C18:3	
	h	25°C	35°C	25°C	35°C	25°C	35°C	25°C	35°C	25°C	35°C	25°C	35°C	25°C	35°(
'Samrat'	MS			17.5	17.5	12.8	12.8	3.5	3.5	20.5	20.5	54.9	54.9	7.5	7.5
	24	46.1	54.4	16.9	16.5	12.8	12.9	3.6	3.6	19.6	19.7	55.7	55.7	7.6	7.7
	48	54.0	58.3	16.6	13.3	12.4	12.3	3.5	3.9	19.4	19.8	56.4	56.2	7.9	7.4
	72	65.7	69.2	12.2	12.5	12.4	12.7	3.4	3.6	19.5	19.5	56.2	56.7	7.4	7.2
	96	74.2	79.1	12.1	11.4	12.3	12.7	3.7	3.7	18.7	19.9	57.0	56.2	7.4	7.4
	120	74.8	83.0	11.6	9.9	11.8	13.8	3.8	3.8	18.7	18.9	57.3	56.3	7.5	7.2
	144	77.0	83.3	11.6	9.9	12.8	12.0	3.7	4.3	16.9	18.8	58.3	56.2	7.9	7.4
'JS335'	MS			18.5	18.5	12.2	12.2	3.3	3.3	23.7	23.7	50.0	50.0	7.2	7.2
	24	43.4	56.9	16.9	16.6	11.6	11.4	3.6	3.9	24.4	24.6	52.9	52.5	6.9	6.8
	48	54.0	63.3	16.0	15.5	11.0	10.7	3.8	3.8	24.4	25.9	52.9	52.0	7.0	6.4
	72	66.5	68.5	14.3	13.9	11.5	10.0	3.8	3.4	24.6	23.5	52.6	54.8	6.7	7.2
	96	71.2	80.7	13.5	11.7	10.7	10.1	3.8	3.9	24.4	23.9	53.2	54.1	6.7	6.9
	120	77.0	82.6	12.1	10.4	10.7	10.5	4.0	4.0	23.2	25.8	54.2	51.9	7.0	6.7
	144	78.0	83.4	11.1	9.8	11.7	11.7	3.7	4.3	19.8	25.9	54.8	51.2	11.7	6.8
LSD		2.82	2.67	0.85	0.87	1.25	1.43	0.46	0.33	1.73	1.83	2.32	2.43	0.62	0.6

*Each value is a mean of triplicate samples; MS: Mature seed

oil content in 'Samrat' was observed between 48 and 72 h of germination at 25°C while it occurred earlier (between 24 and 48 h of germination) at 35°C. A steady decline in oil content during germination was observed in 'JS335' upto 6 days at both the temperatures. The decrease in percent oil content during germination may be ascribed to consumption of oil as energy and/or synthesis of certain structural constituents in young seedlings. Mostafa et al (1987) and Chandasiri et al (1990) also reported decline in percent oil content in 1, 2, 3, 4, 5, and 6 days soybean seedlings sprouted at 23-25°C. Higher decline in oil content at 35°C as compared to 25°C observed in both the genotypes may be due to faster metabolism under higher temperature.

As regard to saturated fatty acids, palmitic (C16:0) and stearic acids (C18:0), there was no change till 120 h (5th day) in both the genotypes at both the temperatures (Table 1). The results obtained are in contrast to earlier report (Mostafa et al 1987) who observed increase in palmitic acid content during germination. However, in our studies there was no increase in palimitic acid content but a higher level of stearic acid in 6-day old seedlings developed at 35°C in both the genotypes was observed when compared with that of mature seeds. No significant differences for monosaturated fatty acid i.e. oleic acid (C18:1) were observed upto 120 h in both the genotypes at both the temperatures. However, in seedlings developed at 25°C, there was significant percent decline in the oleic acid content on 6th day as compared to ungerminated seeds in both the genotypes. However, in both the genotypes at germination temperature of 35°C, no significant differences for oleic acid were observed between ungerminated seed and 6-day old seedling. The difference for this fatty acid was more pronounced in 'JS335' than 'Samrat'. Linoleic acid content was more in 6-day old seedlings in both the genotypes as compared to mature seeds at germinating temperature of 25°C. No significant differences were observed for linolenic acid during germination upto 6th day of germination in both the genotypes at both the temperatures.

Conclusively, 6-day old soy sprouts developed at higher temperature (35°C) contained less oil with no significant changes in the concentration of linolenic acid. Hence, soy sprouts developed at higher temperature are healthier as they have reduced fat content while retaining the benefits of omega-3 fatty acids.

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