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STUDIES ON THE PRODUCTION AND PROCESSING ASPECTS OF SUNFLOWER SEEDS

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Sunflower crop is important for India at present for two reasons. It is drought resistant and its seed is a commercially viable source of edible oil. The duration of the crop before the seeds can be harvested merits attention in research on sunflower seed. Oil build-up and its quality in the developing seeds of new hybrids have been studied. Two varieties of seeds, namely, EC-68415 and Morden, have been studied for their decortication property as affected by moisture content of seed, seed size, feed rate and impeller speed.

Major changes in the moisture, oil and its fatty acid profile and wax upto 45 days after flowering (DAF) in the capitulum as well as composition of seeds from the periphery to the centre of the capitulum were studied. The results indicated that the oil accumulation reached a peak at 35 DAF. However, qualitative changes in the oil composition continued beyond this point and after 45 DAF, the fatty acid profile showed high linoleic acid (54.9%) and low oleic acid (28%) as against 68.8% of linoleic acid and 34% of oleic acid at 35 DAF. Immature seeds from the centre of the capitulum indicated a higher degree of saturation as well as wax content to mature seeds.

Callus culture from seed segments had fatty acid composition of oil distinctly different from seeds with high oleic acid (54.8%) and low linoleic acid (22.5%).

Since, variety plays an important role in the economics of the process, the efficiency of sunflower seed hulling on these two varieties was studied. Variety EC-68415 showed greater shelling efficiency and percent fines than the Morden variety. These two parameters increased with (i) increase in size of seed, (ii) increase in impeller speed, (iii) decrease in feed rate, and (iv) decrease in the seed moisture content.

INTRODUCTION

The commercial importance of the sunflower arises from the fact that the achene or seed produces oil which is of edible quality. It hence became an important commercial oilseed crop in the late 1960's. In the early seventies sunflower was introduced in India as a supplementary oilseed crop with the few imported varieties from USSR and Canada, in addition to the group of traditional grown oilseed crops. Among all the sunflower

varieties tried, EC-68413 (Vniimk) , EC-68414 (Perdovic), EC-68415 (Armavirsky 8497) were found adoptable to various agro climatic conditions and different cropping systems. Since these varieties showed some undesirable features to grow in India, R&D efforts were made and some of the varieties obtained after screening and evaluation of germplasm collections found to possess the desirable characters with dwarf habit, early maturing ability, high oil and high yield ability (1). At present,the crop is being cultivated in 0.8 to 0.85 million hectares of land in the country eiether as an entire or mixed or intercrop with a current production of 850,000 tonnes\annum. The possibility of a quantitative improvememt in fatty acids to respond to specific nutritional needs is being evaluated in breeding programmes. The fatty acid composition of sunflower seed oil has been reported by a number of scientists to vary with planting location and with climatic conditions during the growing season (2,3). In addition, the crop has been vexed by varieties that vary in height and maturity. Due to the improper maturity and poor harvesting techniques, poorly filled and unfilled seeds resulting in high wax and low oil content occur (4). Sunflower seed is of a major importance as a source of vegetable oil in India, a fuller understanding of the developments involved in the formation of oils, from flowering stage to seed maturation and work on these new varieties developed in India have considerable relevence.

In India it is very much necessary to harvest the crop after complete maturation in order to avoid possible wastage from unfilled and shrievelled seeds. As immaturity of these seeds is a degrading factor it is of importance to secure defenite information as to its effect on oil and wax contents under Indian conditions. Hence a fuller understanding of the developments involved in the formation of oils in some of the new hybrid varieties have considerable relevance.

Changes in oil content and fatty acid composition during sunflower seed maturation have been investigated on seeds grown Canada, U.K. USSR , Australia, USA, and India (5,6,7,8)

In the present study, the investigations have been carried out on (a) the quantitative and qualitative accumulation of oil in the newly developed sunflower seeds of four different new varieties, namely Morden, EC-68414, Latur-17. and Seriguppa -5 (b) the use of tissue culture techniques as related to lipid metabolism.

MATERIALS AND METHODS

Four different new varieties of sunflower mentioned earlier were chosen for the investigation. The crop was raised under uniform fertility. Each cultivar was grown in 2 replications to ensure uniformity in sampling. In each replication for any particular variety, 30 plants that flowered on the same day were selected and tagged. As soon as pollination was complete, the flower heads were covered with perforated polyethylene bags to

protect the seeds from the birds. Two heads of each variety were harvested at 5 day intervels from the "Day After Flowering" (DAF) upto 40 days, by which time the back of the capitulum became yellow in colour. Some of the capitula in each variety were left upto 60 days to find out further changes in the fatty acid composition. Seed samples investigated at a particular stage of maturity correspond to

(a) The whole seeds of the individual capitulum of each variety

(b) The seeds of each of the outermost to the innermost whorl\row of the capitulum separately

Each sample contained seeds from both the replicates of the respective variety. After one sampling the capitulum was rejected. EC-68414 variety was used as standard for comparison. All the seeds were taken for respective analysis immediately.

Table 1

MOISTURE AND OIL CONTENTS OF FOUR VARIETIES OF SUNFLOWER SEEDS AT DIFFERENT STAGES OF SEED DEVELOPMENT IN CAPITULUM

No. of DAF	EC-68414		Morden		Latur-17		Sireguppa-5	
	Moisture	Oil	Moisture	Oil	Moisture	Oil	Moisture	Oil
5	81.6	6.0	81.7	3.8.	78.9	4.8	80.3	4.8
10	87.6	3.3	87.2	5.6	87.3	6.2	87.1	5.5
15	79.8	10.0	75.4	12.5	80.5	6.9	80.7	7.0
20	64.9	28.1	64.3	34.5	68.3	19.3	64.0	11.8
25	56.0	29.3	62.5	35.3	66.7	34.8	66.7	36.4
30	65.8	32.0	59.4	36.3	34.1	46.0	47.0	37.4
35	31.3	32.4	33.5	36.5	35.4	47.5	40.8	47.2
40	8.1	33.0	18.3	36.8	20.4	47.0	31.8	45.2
45	7.9	34.5	10.9	37.0	15.6	47.5	27.6	46.0
60	5.2	-	6.3	-	8.3	-	12.3	-

TABLE 2.: MOISTURE CONTENT OF FOUR VARIETIES OF SUNFLOWER SEEDS AT DIFFERENT STAGES OF DEVELOPMENT:IN ROW-WISE ESTIMATIONS.

No. of DAF	MOISTURE CONTENT %															
	LATUR -17				EC-68414				MORDEN				SIRIGUPPA-5			
	ROW 1	ROW 2	ROW 3	ROW 4	ROW 1	ROW 2	ROW 3	ROW 4	ROW 1	ROW 2	ROW 3	ROW 4	ROW 1	ROW 2	ROW 3	ROW 4
10	79.6	82.9	88.3	88.9	86.1	88.6	88.8	90.0	86.4	88.8	91.2	92.3	87.3	89.2	90.4	93.2
15	62.5	63.2	69.2	73.3	69.0	70.8	70.8	75.0	70.7	74.0	78.8	79.5	74.3	80.0	83.3	76.9
20	58.3	58.3	60.0	66.0	64.4	64.9	65.6	66.5	55.9	70.0	75.6	66.3	54.3	65.7	66.6	70.4
25	50.0	50.0	48.0	59.0	46.9	46.1	54.5	50.0	45.0	52.6	51.1	54.3	48.4	47.1	47.1	46.9
30	36.1	36.7	30.0	40.0	30.9	31.2	40.0	34.4	37.9	38.6	41.0	41.8	40.5	40.0	43.9	42.1
35	14.3	16.0	22.5	32.0	21.0	20.0	24.4	21.6	36.3	30.0	36.8	37.5	32.7	36.6	30.4	36.6
40	11.2	12.5	17.5	20.0	10.2	11.8	16.8	15.2	24.6	22.0	25.7	23.1	24.2	22.4	21.8	27.3
45	9.8	10.3	12.0	13.2	8.6	10.2	13.5	12.8	16.7	17.1	14.3	20.0	17.9	14.6	17.2	20.0

TABLE-3 : OIL CONTENT OF FOUR VARIETIES OF SUNFLOWER SEEDS AT DIFFERNET STAGES OF DEVELOPMENT:IN ROW-WISE ESTIMATIONS.

No. of DAF	OIL CONTENT % (Moisture-free basis)															
	LATUR 17				EC-68414				MORDEN				SIRIGUPPA 5			
	ROW 1	ROW 2	ROW 3	ROW 4	ROW 1	ROW 2	ROW 3	ROW 4	ROW 1	ROW 2	ROW 3	ROW 4	ROW 1	ROW 2	ROW 3	ROW 4
5	4.7	2.5	0.5	-	3.2	3.0	-	-	7.5	5.8	4.1	3.2	6.8	4.1	1.2	0.7
10	6.8	4.5	3.1	2.0	6.5	5.2	4.5	2.1	14.3	12.3	10.2	8.4	10.1	7.4	5.2	3.2
15	10.1	9.2	7.3	5.1	9.2	8.4	8.0	6.2	25.0	16.0	15.7	12.5	18.8	15.0	15.1	14.0
20	25.6	22.3	20.1	15.7	25.5	24.7	23.7	19.3	29.0	23.0	17.3	15.0	37.5	33.3	33.3	25.0
25	43.7	33.3	24.5	20.3	40.0	33.0	31.5	28.5	33.3	31.5	22.2	20.0	42.6	34.4	28.3	23.3
30	61.4	45.7	28.6	25.0	52.5	47.5	37.5	30.5	38.8	34.5	26.8	22.5	46.9	37.4	33.7	27.6
35	62.8	46.6	34.3	23.4	55.6	50.0	44.3	32.4	48.3	38.4	36.6	29.4	51.1	40.0	35.7	32.4
40	63.0	47.8	35.2	24.2	56.4	50.7	44.8	32.8	49.2	40.1	37.3	30.1	51.4	40.4	36.4	32.0
45	63.1	48.0	35.8	24.8	56.7	51.1	45.2	33.0	50.1	40.8	37.8	30.4	52.5	41.1	37.1	32.0

Analysis of oil, moisture and protein were determined according to AOCS procedure(9). Metyl esters were prepared according to the method of Luddy etal (10), fatty acid composition was determined using Gas Chromatography on a Shimadzu C-RCA Chromatopac equipped with hydrogen flame ionization detector and PEGS column. Nitrogen as a carrier gas was used with a flow rate of 50-60 ml\min. Air pressure was maintained at 0.35 kg\cm and hydrogen pressure at 0,6 kg\cm ;p column temperatuire was maintained at 185 C and injection temperature at 230 C.

RESULTS AND DISCUSSION

The moisture content in sunflower seeds of capitulum showed gradual decrease from 80% to 5% with progressive maturity. The individual seed rows starting from peripherry, the moisture content. increased towards the centre of the capitulum from 80% (first row) to 90% (fourth row) at 10 DAF and 8.6% (first row) to 13.2% (fourth row) at 45 DAF. The peak period of oleogenesis in the seed varied with the varieties studied; but the oil accumulation reached maximum between 25 and 30 DAF in various varieties, afterwhich there was not much change in the oil percentage (Table1,2). Studies on the oleogenesis in individual seed rows starting from periphery and progressing towards centre of the flower indicated that (Table 3) the oil accumulation occurred to the highest extent in the outermost row of seeds (63% in first row) and gradually decreased towards the centre. (24.8% at the fourth row). The oil content in the seeds of the central portion of capitulum in shrievelled and unfilled seeds were very low (3.9% - 4.8%) in all the varieties (Table4). Analysis of fatty acids in all the varieties at various stages of maturity showed high saturated fatty acid content at the initial stages and it decreased gradually to the lowest extent at its final maturity. In all the Varieties the oleic acid content was lower at the initial stages (4-12.5%) and gradually increased

Table 4: Oil, fatty acid and wax content of unfilled and shrivelled seeds of Seriguppa-5 variety at 45 DAF

Oil content	4.8%	
Fatty acids	Palmitic	13.0%
	Stearic	2.9%
	Oleic	29.0%
	Linoleic	49.0%
Wax content (Per 100 g. of oil)	1.8 to 2.4%	

TABLE -5 : PERCENTAGE OF FATTY ACIDS AND IODINE VALUES IN OIL OF SEEDS IN CAPITULA OF FOUR SUNFLOWER VARIETIES AT DIFFERENT STAGES OF SEED DEVELOPMENTS

VARIETY: EC - 68414

No.of DAF	SATURATED ACIDS			UNSATURATED ACIDS			IODINE VALUE
	Palmitic	Stearic	Total	Oleic	Linoleic	Total	
5	25.1	2.5	47.6	9.9	54.5	64.4	102.8
10	27.1	4.7	31.8	20.4	48.7	69.1	101.8
15	13.4	3.2	16.6	36.4	46.2	86.6	111.2
20	6.3	4.4	10.7	42.3	47.0	89.3	117.6
25	8.0	3.0	11.0	46.7	41.9	88.6	112.8
30	8.1	4.2	12.3	27.5	60.2	87.7	128.6
35	6.0	4.8	10.8	32.1	49.1	81.2	112.5
40	5.8	5.1	10.9	40.7	48.0	88.7	118.0
45	5.5	5.0	10.5	42.1	47.2	89.3	117.9
100	4.5	3.8	8.3	52.5	39.0	91.5	112.6

TABLE-5 . (Continued). VARIETY : MORDEN

No.of DAF	SATURATED ACIDS Palmitic	Stearic	Total	UNSATURATED ACIDS Oleic	Linoleic	Total	IODINE VALUE
5	32.6	2.3	34.9	12.3	52.8	65.1	101.9
10	18.5	6.1	24.6	24.9	50.5	75.4	108.7
15	10.3	4.2	14.5	34.8	43.2	78.0	104.6
20	7.1	3.5	10.6	59.0	30.3	89.3	103.2
25	5.6	5.0	10.6	31.9	57.2	69.1	126.4
30	6.9	2.8	9.7	34.1	56.2	90.3	126.6
35	4.5	2.7	7.2	53.2	39.6	92.8	114.3
40	5.2	3.5	9.7	60.9	30.4	91.3	105.1
45	4.7	3.6	8.3	48.4	43.3	91.7	116.5
100	5.0	3.9	8.9	39.3	51.8	91.7	123.4
			VARIETY: LATUR-17				
5	28.3	3.2	31.5	4.1	33.2	37.3	60.9
10	17.4	7.2	24.6	8.3	50.2	58.5	93.9
15	8.2	9.9	18.1	15.4	66.3	81.7	127.7
20	5.3	5.7	11.0	26.9	61.7	88.6	127.7
25	5.4	5.0	10.4	38.3	51.5	89.8	121.8
30	6.0	5.9	11.9	23.1	64.9	88.0	132.4
35	2.4	2.9	5.3	22.8	68.3	89.1	136.1
40	1.8	3.0	4.8	21.3	69.0	90.3	137.7
45	2.0	2.0	4.0	20.4	71.0	90.4	138.6

TABLE - 5 .(Continued). SIRIGUPPA - 5

No.of DAF	SATURATED ACIDS Palmitic	Stearic	Total	UNSATURATED ACIDS Oleic	Linoleic	Total	IODINE VALUE
5	21.4	1.8	23.2	4.8	62.4	67.2	112.0
10	16.4	3.2	19.6	12.4	58.1	70.5	111.1
15	8.0	8.3	16.3	28.2	54.7	82.9	118.9
20	7.8	5.6	13.4	24.9	60.2	85.1	125.5
25	5.5	4.7	10.2	38.3	51.5	89.8	121.9
30	5.3	4.4	9.7	29.9	60.2	90.1	129.9
35	4.8	3.4	8.2	34.4	58.8	92.2	126.8
40	4.4	4.8	9.2	30.4	60.1	90.5	122.3
45	4.6	6.7	11.3	28.3	54.9	83.2	121.5

TABLE- 6 PERCENTAGES OF FATTY ACIDS AND IODINE VALUES IN SEEDS OF FOUR VARIETIES OF SUNFLOWER AT VARIOUS STAGES OF SEED DEVELOPMENT - IN ROW-WISE ESTIMATIONS

VARIETY : LATUR - 17

No. of DAF	Row No.	Percentage of fatty acids				Iodine value
		Saturated		Unsaturated		
		Palmitic	stearic	oleic	linoleic	
15	1	6.9	7.0	26.4	59.7	125.9
	2	7.4	7.7	23.2	61.5	126.3
	3	4.5	6.3	32.0	63.9	137.7
	4	6.7	4.5	30.0	64.2	136.7
20	1	6.6	6.8	25.2	61.3	127.8
	2	8.1	6.3	26.7	58.8	124.7
	3	7.5	5.8	29.9	56.3	123.2
	4	7.6	7.2	23.1	61.9	127.0
25	1	6.0	7.3	43.3	50.3	124.3
	2	6.1	7.6	39.4	46.0	113.5
	3	6.2	7.5	38.4	47.3	114.9
	4	10.6	6.2	21.1	61.0	123.6
30	1	5.5	8.4	30.5	55.5	122.2
	2	5.8	7.6	25.6	60.8	127.2
	3	6.1	7.9	27.3	58.3	124.3
	4	6.4	8.0	26.7	58.3	123.9

Table- 6 VARIETY : SIRIGUPPA -5

No. of DAF	Row No.	Percentage of fatty acids				
		Saturated		Unsaturated		Iodine value
		Palmitic	stearic	oleic	linoleic	
15	1	9.9	3.9	17.0	69.0	134.0
	2	10.6	4.1	18.2	66.8	131.3
	3	10.3	4.3	21.4	63.2	127.8
	4	12.9	6.5	25.5	54.1	115.4
20	1	5.4	4.9	40.8	48.2	118.7
	2	5.1	4.7	43.2	46.9	118.4
	3	3.9	3.1	28.8	46.7	95.4
	4	4.8	5.3	42.1	47.5	118.6
25	1	4.5	3.8	36.9	54.6	126.0
	2	4.8	3.4	33.7	57.8	129.0
	3	5.2	4.0	33.3	56.0	125.5
	4	5.2	3.6	32.4	58.7	129.5
30	1	5.3	5.2	35.6	53.8	123.9
	2	5.8	4.9	33.9	55.1	124.6
	3	5.3	5.0	32.1	55.5	124.5
	4	5.7	5.5	31.7	56.9	125.8

Table- 6 . (Continued) VARIETY : MORDEN

No. of DAF	Row No.	Percentage of fatty acids				Iodine value
		Saturated		Unsaturated		
		Palmitic	stearic	oleic	linoleic	
15	1	6.2	4.9	19.9	68.9	136.3
	2	8.1	6.6	22.6	61.9	126.5
	3	7.1	6.1	18.4	67.9	133.3
	4	7.5	6.0	18.2	68.0	133.3
20	1	6.1	4.0	34.8	59.0	145.4
	2	5.5	4.6	38.0	51.7	128.9
	3	6.2	4.2	36.0	53.4	123.3
	4	6.1	4.4	36.3	53.0	122.9
25	1	5.4	3.6	16.7	74.2	142.7
	2	7.9	5.9	24.9	60.4	125.9
	3	6.8	5.5	24.5	62.3	128.8
	4	6.8	5.4	24.0	63.0	129.6
30	1	6.8	5.1	23.9	64.1	131.5
	2	6.5	4.6	24.5	64.2	132.0
	3	6.5	3.7	24.0	65.9	134.6
	4	6.0	3.0	25.0	66.0	135.7

upto 40 DAF. However after 30 DAF, oleic acid content showed decreasing trend during maturation (45 DAF). The linoleic acid content was high at the initial stages and varied from 35-81% in all the varieties. There was a gradual decrease upto 20 DAF and showed stabilisation towards maturation. Inter conversion of oleic acids and linoleic acids was indicated by corresponding change in the percentages. Likewise conversion of saturated and unsaturated fatty acids was also indicated by corresponding changes in values. Observation on fatty acid content of oil extracted from seed rows indicated no significant changes in their composition first to fourth row (Table 6). Physiological maturity of sunflower seed indicated by minimum moisture and maximum oil percentage has been designated for different varieties. This stage was reached in varieties between 35 and 40 DAF. Wax content estimated in Sireguppa-5 variety showed an increasing trend during different stages of maturity. At 25 DAF, the content was 0.031% and it increased to 0.052% at 45 DAF

The fatty acids in oil from callus cultures showed high linoleic acid and low oleic acid content, whereas it was vice-versa in oil from in vitro conditions. Total saturated acid in oil from in vivo conditions were much higher than those under in vivo conditions. unsaturated acids constituted a higher percentage under in vitro conditions, while under in vivo conditions, it was lower (Table 7).

Table 7

FATTY ACID COMPOSITION OF OIL FROM SIREGUPPA-5 SUNFLOWER VARIETY UNDER in vivo AND in vitro CONDITIONS

Fatty acid content	In vitro	In vivo
Palmitic	11.65	8.0
Palmitoleic	1.55	0.0
Stearic	9.02	8.3
Oleic	54,87	28.2
Linoleic	22.9	54.7

Sunflower seed has a fairly high proportion of hull and dehulling before oil expression has many advantages (11); better quality oil (lower wax content and improved colour), better quality extracted flour (increased protein content and lower

fibre content). Since variety plays an important role in the economics of the process, the efficiency of sunflower seed hulling on these two varieties were studied. Cleaned, graded seeds were dehulled on an impact dehuller (12). The shelling efficiency and percent fines increased with increase in impeller speed. At the same operating conditions EC-68414 variety seeds having the same size and same moisture content as those of the Morden variety show greater shelling efficiency and percent fines. This may be due to kernels being more loosely held in the seed of EC-68414 than Morden variety. In general, large size seeds show greater shelling efficiency, since large seeds are more mature and the the centrifugal force is greataer being proportional to the mass of the seed, the maximum shelling efficiency observed was 79.1% at 3% moisture and lowest was 64.2% at 5.8% moisture.

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