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Studies on changes in the peroxide value on thermal treatment of specific parental lines of Safflower (Carthamus tinctorius L.) of Indian origin

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ABSTRACT

The chemical composition of an edible oil is an important factor in determining the shelf life and it's foremost usability like consumption by human beings. In the present study some parental lines of safflower have been evaluated for this quality using peroxide value as a tool. These varieties have been selected on the basis of high and low Linoleic acid content, polyunsaturated fatty acid (PUFA). The peroxide value (PV), which depends on temperature and frying time, measures the extent of primary oxidation of oils (rancidification). Rancidity of oils can produce potentially toxic compounds associated with long-term health effects such as cancer,heart problems and neurological disorders. Oil of the selected varieties was heated to different temperatures, as under normal household cooking environment and subjected to peroxide value determination. It was noticed that frying temperatures cause changes in peroxide values to a harmful extent with a positive correlation between linoleic acid percent and oxidative rancidity.

Keywords: Safflower oil, Linoleic acid content,Shelf life, Peroxide value, Oxidative rancidity.

INTRODUCTION

Safflower (Carthamustinctorius L.) is an annual herb grown in India since ancient times. Earlier it was a source of color production and was planted in a row for protection around the field but now has reached a respectable position among traditional oilseed crops. The plant is known to possess many medical values. Seeds contain 30-40% of the oil but this may vary from 52 to 70% depending on the current weather and other environmental factors. Oil is particularly praised for being rich in linoleic acid and oleic acid. [1]

The growing demand for polyunsaturated foods makes it a desirable crop of oilseeds. [2]. Although consumed as an edible oil, the high iodine value and high content of linoleic acid indicate that the oil is prone to oxidation, reducing its shelf life. [3]. Linoleic acid with its doubly allylic C-H groups is the main component of normal safflower oil which is most reactive to oxygen leading to the formation of hydroperoxide and hydroxides. This significantly reduces the keeping quality of the oil.

The present study is carried out to identify parental lines which offer better storability and shelf life in 20 different lines ofCarthamus species, selecting ten varieties each of high and low linoleic acid.

MATERIALS AND METHODS

Seed oils of following germplasm were taken in the present study,obtained from the Local Agriculture University. The varieties selected for the study were fromAVT Advanced Varietal Trials, CTV, CSS, 6508, CTV 223, CTV 205, CTV 202, CTV 210, CSS-158, CSS 19-1, TM-29, CTV 218 and NDS-158,with a high percentage of linoleic acid, CTV 212, CTV 216, CTV 217 SVT, NDS-1, T-65, AVT, CVT, CVT 187, CTV 197, AVT, A-1 [NC] CSS-19 and SVT-152 and two IET and CVT trials of the national standard class, with low percentage of linoleic acid. Analysis of fatty acid composition and oil content conducted in the previous study was used to select the 10 varieties mentioned above for both high and low linoleic acid. [5]

CHEMICAL ANALYSIS

The peroxide value of all 20 varietiesis found according to the standard method. Initially, oil was extracted in a simple soxhlet extraction method using 40º-60ºBp of petroleum ether as a solvent for all selected varieties.

Pure oil dissolved in Acetic acid - chloroform mixture left to react with saturated potassium iodide solution for 5 minutes and kept in dark. 100 ml of deionized water was added along with two drops of starch solution. Free iodine was titrated with0.1M sodium thiosulphate solution.[6]

Samples of high and low linoleic acid selected were subjected to heat treatment by frying potato chips for six hours a day for six days at five different temperatures, viz., 160°C, 170°C, 180°C, 190°C and 200°C in a temperature-controlled fryer. Changes in the peroxidevalue after heating coupled with frying was noted and reported in meq/kg.

RESULTS AND DISCUSSIONS

A. Peroxide values

Peroxide value is one of the most important parameters for ascertaining the quality of oil for edible purposes.[7]
It is a measure of the extent to which an oil sample undergoes primary oxidation. Temperature is a predisposing factor in any type of oxidation. Auto-oxidation leads to development of off- flavor and off-odor in four steps. The mechanism of starting and completing the process is extremely complex and governed by a number of factors such as catalyst, the presence of pro and antioxidants, photo-oxidation and the relationship between oxidation rate and oil stability. The double bonds (unsaturation) found in fats and oils aids in auto-oxidation. Peroxides are an intermediary for auto-oxidation reaction. [8]

Peroxide has been found to have adverse effects on human health and is associated with various diseases such as cancers, cardiovascular diseases, obesity and allergies. [9]

All types of oils analyzed showed very low values of PV (peroxide value) (Table 1)

Values ranged from 1.91 for line NDS-1 to 2.59 for CTV-23 between high linoleic acid samples

Table -1. Peroxide values for different lines of linoleic high-acid safflower oil

line	Linoleic acid content (%).	Peroxide value (meq./kg)
6508	81	2.05
CTV223	87.6	2.59
CTV205	80.2	2.07
CTV202	83.2	2.44
CTV210	79.8	1.99
CSS158	83.1	2.34
CSS19-1	81.4	2.22
TM-29	77.3	2.15
CTV218	78.2	1.95
NDS-1	78.9	1.91

Table -2.Peroxide values for different lines of low linoleic acid safflower oil

line	Linoleic acid (%).	Peroxide value
CTTV212	65.5	1.6

CTTV216	68.7	1.5
CTTV217	66.0	1.4
SVT، NDS-1	59.1	0.9
T-65	64.2	1.2
AVT CVT187	48.4	0.5
CTTV 197	64.8	1.2
AVT، A-1 (N.C)	65.6	1.3
CSS-19	60.1	1.0
SVT152	61.5	1.1

Table 2 shows peroxide values for low-linolenic acid lines.

These values ranged from 1.91 to 2.59 for high linoleic acid samples and from 0.9 to 1.6 for low linoleic acid samples. High linoleic acid content in the oil makes it a temperature sensitive and this is against its stability and shelf life. On the other hand, low linoleic acid oil is temperature sensitive with no significant change in oil during long storage. [10]

Table 2(a) Peroxide values of safflower oil after heating to different temperatures in high linoleic acid samples

Line	Linoleic acid content (%)	Peroxide Value (PV) meq/kg	PV meq/kg(160^{0}C)	PV meq/kg (170^{0}C)	PV meq/kg (180^0 C)	PV meq/kg (190^{0}C)	PV meq/kg (200^0 C)
6508	81	2.05	3.7	5.4	7.3	9.1	10.1
CTV223	87.6	2.59	3.9	5.8	7.3	9.0	10.1
CTV205	80.2	2.07	3.3	4.9	6.7	8.4	9.6
CTV202	83.2	2.44	3.7	5.3	7.0	8.5	9.6
CTV210	79.8	1.99	3.2	5.1	6.8	6.5	9.5
CSS158	83.1	2.34	3.6	5.2	6.9	8.8	9.5
CSS19-1	81.4	2.22	3.5	4.6	6.6	8.2	9.2
TM29	77.3	2.15	3.4	4.6	6.8	8.0	9.1
CTV218	78.2	1.95	3.2	4.8	5.6	8.1	9.1
NDS-1	78.9	1.91	3.1	4.5	6.7	8.2	9.2

Table 2(b) Peroxide values of safflower oil after heating to different temperatures in high linoleic acid samples

Line	Linoleic acid (%)	Peroxide Value (PV)	PV meq/kg (160°C)	PV meq/kg (170°C)	PV meq/kg (180°C)	PV meq/kg (190°C)	PV meq/kg (200°C)
CTV212	65.5	1.6	1.9	2.8	4.2	5.3	6.7

CTV216	68.7	1.5	2.0	3.0	3.8	5.0	6.8
CTV217	66.0	1.4	1.8	2.9	4.5	5.4	6.9
SVT,NDS-1	59.1	0.9	1.5	2.8	4.1	4.8	6.4
T-65	64.2	1.2	1.8	2.7	4.1	5.4	6.5
AVT CVT187	48.4	0.5	0.7	1.3	2.0	2.5	3.1
CTV197	64.8	1.2	1.6	2.9	4.0	5.3	6.6
AVT,A-1(N.C)	65.6	1.3	1.8	2.9	4.1	5.2	6.6
CSS-19	60.1	1.0	1.5	2.7	4.0	5.1	6.5
SVT152	61.5	1.1	1.5	2.6	4.0	5.2	6.5

Table 2 (a) and 2(b) shows the peroxide value of the oils of different cultivars of safflower oil after heating (coupled with frying), to five different temperatures, viz. 1600C, 1700C 1800C, 1900C and 2000C.

At160C, the highest peroxide value was observed for a variety of CTV 223 which happened to be the highest sample of linoleic acid with a linoleic acid percentage of 87.6. At other temperatures also PV is the highest for this variety. The average peroxide value for this variety is 6.46. The variety NDS-1 containing 78.8 percent of linoleic acid had the mean PV 5.73.

For low linoleic acid samples, the line CVT 187 (AVT) , which contains minimum percentage of linoleic acid, had an average peroxide value of 1.68 while the value of ambient peroxide value was 0. 5.The variety, NDS-1 of the SVT trial with 59.1% linoleic acid had an average peroxide value of 3.41.CTV 216 line which contained 68.7% linoleic acid, maximum among low linoleic acid samples showed an average peroxide value of 3.68.

CONCLUSION

These results show varietal differences to peroxidation at different temperatures.With increase in linoleic acid content, there is a corresponding increase in the average peroxide values of the samples.

From the study of peroxide values of heated oil, it was noted that high temperature coupled with repeated cookings increased peroxidation at a harmful level in case of high linoleic acid oils. Albeit, a similartemperature treatment to low linoleic acid oil samplesthe spoilage due to peroxidation was within acceptable limits.

Correlation between the linoleic acid percentage and the peroxide value was positive and highly significant (+40.75). This correlation is wealth of information revealing that it is the linoleic acid content mainly responsible for spoilage at elevated temperatures. High temperature results in faster deterioration of oil, so it is necessary to maintain the oil temperature during frying at a low degree to check for deterioration.

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