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Effect of Essential Oil and Oleo Resin on Stability of Edible Oil Blends

AFINISHA DEEPAM L.S.[1,2,*] and KARDILE AMOL[1]

[1]Department of Food Sciences and Technology, Karunya University, Coimbatore-641 114, India
[2]Department of Chemistry, Christian College, Kattakada-695 572, India

*Corresponding author: E-mail: afinishadpm@gmail.com

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Edible oils having lower amount of saturated fat and higher amount of unsaturated fat is essential for better biological activity. Blends of rice bran oil (RBO), coconut oil (CO), sesame oil (SSO), sunflower oil (SO), olive oil (OO) have monounsaturated, polyunsaturated and saturated profile. Essential oil of cardamom, clove, paprika and oleoresins of ginger, black pepper and paprika were used in various concentrations to constitute flavour and pungency in blends. Stability of the normal blends and spice extract added blends were analyzed by studying free fatty acid, peroxide value and diene value. Results showed profound decrease in the oxidation products in spice added blends than normal blends. Paprika oil added CO:RBO (60:40), OO:RBO (60:40) showed lesser value than normal blends.

Keywords: Essential oil, Oleo resin, Stability, Edible oil.

INTRODUCTION

The health and nutritional aspects of edible oils in food and food products are receiving increasing attention. Vegetable oils are the main source of dietary fats for all people in India. In addition to this various phytochemicals also present in vegetable oil.

Rice bran oil (RBO) extracted from the germ of rice containing unique compounds having relatively high unsaponifiable componds. It has high concentration of sterols, γ-oryzanol, tocopherols, tocotrienols, *etc*. compared to other common vegetable [1]. Smoke point of RBO is 213 °C and so it is suitable for high-temperature cooking [2]. Studies showed that RBO lowers plasma cholesterol more effectively than other commonly used vegetable oils. Other potential properties of RBO includes modulation of pituitary secretion, inhibition of gastric acid secretion, antioxidant action, inhibition of platelet aggregation, lowering of blood pressure regulation of cholesterol *etc*. [3].

Olive oil (OO) is commonly using in cooking, pharmaceuticals, soap industry, cosmetics, *etc*. It is composed of fatty acids *e.g.*, oleic acid and palmitic acid, *etc*. It contains phenolics having positive effects on physiological parameters such as plasma lipoproteins, oxidative damage, inflammatory markers, platelet and cellular function antimicrobial activity, *etc*. The phytochemicals in olive oil showed potent antioxidant properties [5]. The compounds hydroxytyrosol, oleocanthal, oleuropein aldehydic secoiridoids, flavonoids lignans acetoxypinoresinol, pinoresinol, tyrosol, *etc*. have various effects.

Sunflower oil (SO) is commonly used as food as frying oil. Sunflower oil contains linoleic acid as essential fatty acid. Sunflower oil contains cholesterol lowering phytosterols and also it contain high level of proteins and minerals such as magnesium, copper, *etc*. Sunflower oil shows anti-inflammatory and cardiovascular benefits on human body and high level of magnesium helps to reduce the severity of asthma, blood pressure, as well as reducing the risk of heart attack and stroke [5].

Sesame oil (SSO) is known to have higher percentage of polyunsaturated fatty acids (ω6 fatty acids). It is unique and it contain phytochemicals such as sesamol and sesamin. Sesame oil lowers systolic and diastolic blood pressure remarkably in hypertensive patients. It also prevents the formation of atherosclerotic lesions in mice fed with atherogenic diet. Studies shows that it helps in preventing ageing [6] inhibiting the proliferation of wide range of cancer cells. Coconut oil (CO) is a saturated oil contains medium chain fatty acids (MCFA) and exhibits good digestibility.

Various reports showed blending of oil increases the ratio of saturated, mono unsaturated and polyunsaturated fatty acids. It improves the nutritional quality, acceptance and also stability of the oil. The addition of spices into food emulsions improves their consumer acceptance and flavour characteristics. Besides sensory profile, spices also improve oxidative stability of vegetable oils. They may serve as natural food preservatives, too. Many reports shown addition of spice increased antioxidative activity as well as other activities [7]. Various reports have

shown the effect of spices on the oxidative stability of oil emulsion.

The potent sources of natural antioxidants are spices [8] increase the shelf life of oil by their bacteriostatic activity. The present investigation highlights the effect of addition of spice extracts in various blends of rice bran oil, olive oil, coconut oil, sunflower oil, sesame oil *etc.*

EXPERIMENTAL

Refined rice bran oil, olive oil, coconut oil, sesame oil and sunflower oil obtained from the local market of Coimbatore. All chemicals and solvents were analytical grade. Spice extracts were received as a gift from a company.

Chemical characteristics of oils: Chemical analysis such as free fatty acid content, peroxide value, *p*-anisidine value, saponification value determined by following AOCS procedure [9].

Blending of oils: Blending of oils were carried out accordance with the FSSAI rules by following weight ratios. The blends were stirred in a magnetic stirrer for 20 min to get homogenized. The blend ratio was optimized by analyzing the fatty acid composition of individual oil by considering the saturated, mono unsaturated and poly unsaturated fatty acid.

Stability Studies: The blends were stored in hot air oven at 60 °C for 5 days and the stability of blends were studied based on chemical characteristics.

RESULTS AND DISCUSSION

Physico-chemical analysis data of all blends and individual oil is shown in Table-1. It shows SSO:SO blend of 80:20 having higher free fatty acid value of 1.08 and CO:RBO (60:40) having lesser free fatty acid value 0.37 among blends. In the case of peroxide value, sesame oil was having less value (1.12) and olive oil having higher value. This is in agreement with the presence of free fatty acid. In blends, OO(60):RBO(40) having higher value of 5.60 mequiv/Kg. This may because the individual oil taken for blending is having higher peroxide value at the time of mixing. Among the blends SSO(80):SO(20) having lowest peroxide value of 1.67 mequiv/Kg. Saponification value of individual oils were agreeing with the standard values [10]. In blends CO:RBO (60:40) having higher value 231.31, OO:RBO (60:40) 77 which is a lesser value of 176.2. SO:SSO (80:20) and OO:RBO (60:40) having approximately equal values. Iodine value of blends SO(80):SSO(20) having higher value of 125 and in all the coconut oil blends lesser iodine value because of less unsaturation. Iodine number and the iodine value of blends correspondingly reduced [11]. SO:SSO both 80:20 and 20:80 having comparable values.

Stability studies of various blends

RBO:CO: The results obtained from the stability studies of coconut oil and rice bran oil is shown in Table-2. From the results it has been showed that RBO:CO blend of ratio 80:20 having higher free fatty acid values from day 1 to day 3 when compared with other blends. Among all blends RBO:CO 20:80 have lesser free fatty acid values from initial day to final day. It may due to the less percentage of unsaturated fatty acid in RBO:CO(20:80) [12]. The percentage of fatty acid varies the formation of peroxides in the sample. The results showed RBO:CO (60:40) having the lesser percentage of peroxide formation through the study and RBO:CO 80:20 having highest percentage. Comparing RBO:CO (20:80) and (40:60) the rate of increasing peroxide is higher than other two ratios (60:40, 80:20). Among the blends it can conclude RBO:CO (40:60) having higher stability. The results are showed in Table-2.

RBO:OO: In RBO:OO blends both 40:60 and 60:40 ratios have lesser free fatty acid values compared to 20:80 and 80:20 ratios of RBO:OO. While comparing all the blends there is no wide difference between the values. It may due to the antioxidant compounds presents in rice bran oil and olive oil [13]. The rate of decrease of free fatty acid vale is also less in all blends. The final day peroxide value of all the blends showed lesser difference and among them RBO:OO 20:80 have 15.3 mequiv/Kg and RBO:OO 60:40 have 20.7 mequiv/Kg. In the case of RBO:OO 60:40 the percentage decrease of free fatty acid is less from initial day to final day and it can be correlated with decreased peroxide value throughout the study. From the blends RBO:OO 60:40 having greater stability followed by RBO:OO 40:60. The result is shown showed in Table-2.

SO:SSO: Various reports showed sesame oil and sunflower oil blends have greater stability. The present study also supports by showing lesser free fatty acid and peroxide value throughout the study. The values are shown in Table-2. The presence of various phytochemicals reduces the formation of free fatty acid and there by peroxides. From day 1 to day 5 the rate of increase of free fatty acid is less throughout the study and similarly the peroxide value showed a maximum value of

TABLE-1
PHYSICO-CHEMICAL CHARACTERISTICS OF INDIVIDUAL AND OIL BLENDS

Parameters	Free fatty acid value	Peroxide value	Saponification value	Iodine value
RBO	0.770 ± 0.019[a]	2.320 ± 0.0890	166.70 ± 0.090	108 ± 0.0430
OO	1.450 ± 0.410	4.200 ± 0.0220	190.00 ± 0.1000	79.18 ± 0.0143
CO	0.336 ± 0.240	ND	240.49 ± 0.4242	8.00 ± 0.0056
SO	0.468 ± 0.750	1.302 ± 0.3800	162.00 ± 0.1800	137.00 ± 0.0700
SSO	0.655 ± 0.870	1.116 ± 0.5400	184.40 ± 0.3100	117.30 ± 0.1600
RBO(60):OO(40)	0.720 ± 0.120	4.460 ± 0.0510	194.90 ± 0.0320	101.97 ± 0.0070
OO(60):RBO(40)	0.640 ± 0.079	5.600 ± 0.0020	176.20 ± 0.0090	83.40 ± 0.0100
RBO(60):CO(40)	0.516 ± 0.000	3.000 ± 0.2828	225.00 ± 0.0424	63.00 ± 0.0042
CO(60):RBO(40)	0.369 ± 0.048	1.800 ± 0.2800	231.31 ± 0.0042	44.00 ± 0.0021
SO(80):SSO(20)	0.908 ± 0.240	1.860 ± 0.0700	177.00 ± 0.7900	125.00 ± 0.1200
SSO(80):SO(20)	1.081 ± 0.063	1.674 ± 0.7500	186.00 ± 0.2300	121.00 ± 0.0890

RBP = Rice bran oil; CO = Coconut oil; SSO = Sesame oil; SO = Sunflower oil; OO = Olive oil.

TABLE-2
STABILITY STUDIES OF EDIBLE OIL BLENDS

Blends	Free fatty acid value					Peroxide value				
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 1	Day 2	Day 3	Day 4	Day 5
RBO:CO										
RBO:CO 20:80	0.575 ± 0.148	0.641 ± 0.034	0.599 ± 0.067	0.47 ± 0.098	0.588 ± 0.07	1.125 ± 0.176	2.132 ± 0.454	3.36 ± 0.00	4.165 ± 0.219	3.9 ± 0.282
RBO:CO 40:60	0.435 ± 0.041	0.645 ± 0.00	0.639 ± 0.047	0.504 ± 0.048	0.378 ± 0.059	1.4 ± 0.245	4.2 ± 0.42	6.7 ± 0.56	7.2 ± 0.10	9.3 ± 0.27
RBO:CO 60:40	0.588 ± 0.03	0.618 ± 0.055	0.59 ± 0.076	0.731 ± 0.061	0.645 ± 0.00	4.83 ± 0.361	6.8 ± 0.023	15.15 ± 0.21	17.39 ± 0.042	19.2 ± 0.00
RBO:CO 80:20	0.87 ± 0.065	0.901 ± 0.00	1.3 ± 0.13	0.552 ± 0.051	0.484 ± 0.076	7.80 ± 0.283	11.36 ± 0.00	18.35 ± 0.49	19.67 ± 0.16	21.0 ± 0.82
RBO:OO										
RBO:OO 20:80	0.85 ± 0.047	0.85 ± 0.63	0.609 ± 0.27	0.58 ± 0.05	0.62 ± 0.75	5.9 ± 0.86	6.7 ± 0.35	11.0 ± 0.45	9.2 ± 0.67	15.3 ± 0.37
RBO:OO 40:60	0.97 ± 0.071	0.73 ± 0.52	0.48 ± 0.068	0.42 ± 0.087	0.50 ± 0.004	6.2 ± 0.041	9.5 ± 0.59	13.1 ± 0.71	17.2 ± 0.37	21.3 ± 0.41
RBO:OO 60:40	0.85 ± 0.13	1.09 ± 0.15	0.48 ± 0.47	0.48 ± 0.016	0.52 ± 0.58	4.83 ± 0.018	7.2 ± 0.27	6.1 ± 0.87	15.1 ± 0.54	20.7 ± 0.48
RBO:OO 80:20	0.66 ± 0.89	1.09 ± 0.93	0.75 ± 0.40	0.85 ± 0.59	0.74 ± 0.47	7.82 ± 0.60	11.63 ± 0.38	17.3 ± 0.43	20.1 ± 0.75	22.5 ± 0.53
SSO:SO										
SO:SSO 80:20	0.908 ± 0.6	1.03 ± 0.07	1.03 ± 0.012	1.17 ± 0.55	1.43 ± 0.47	2.06 ± 0.24	2.32 ± 0.58	2.84 ± 0.18	2.84 ± 0.34	3.61 ± 0.74
SO:SSO 60:40	0.519 ± 0.12	0.78 ± 0.11	1.04 ± 0.09	1.17 ± 0.18	1.17 ± 0.37	1.55 ± 0.14	2.06 ± 0.74	2.32 ± 0.67	2.32 ± 0.278	2.58 ± 0.48
SO:SSO 20:80	1.08 ± 0.063	1.037 ± 0.7	1.17 ± 0.4	1.17 ± 0.85	1.42 ± 0.25	2.060 ± 0.67	2.32 ± 0.48	2.32 ± 0.87	2.83 ± 0.78	3.35 ± 0.97
SO:SSO 40:60	0.778 ± 0.08	1.04 ± 0.15	1.43 ± 0.19	1.56 ± 0.58	1.95 ± 0.97	2.06 ± 0.37	2.84 ± 0.53	3.09 ± 0.61	3.87 ± 0.18	3.87 ± 0.57

RBO = Rice bran oil; CO = Coconut oil; SSO = Sesame oil; SO = Sunflower oil; OO = Olive oil.

3.87 mequiv/Kg (SO:SSO 40:60). The blend SO:SSO 60:40 initially showed peroxide value 1.55 and reach 2.58 having lesser free fatty acid values from initial day to final day. It can be con-cluded that among the samples. SO:SSO 60:40 is better than other blends. The phytochemicals present in SO and SSO such as tocopherols (vitamin E), choline, betaine, reported that it has a greater effect in keeping the stability of oil [5,14].

Stability studies of blends having essential oil constituting flavour

RBO:CO blends: From the analysis of blends without adding extract RBO:CO (60:40) and (40:60) showed minimum values of free fatty acid and peroxide which shows that the stability can be enhanced by adding spice extract. The spice extracts added in the oil blends showed both physical as well as chemical characteristics as improved. The rate of formation of free fatty acid is decreased in both the cardamom oil added blends of CO:RBO (60:40). Table-3 showed that blend RBO:CO (40:60) and RBO:CO (60:40) have free fatty acid value 0.378 for the final day. Comparing the value with blends in Table-2 there is a considerable decrease of free fatty acid as days passed. Diene value measures the formation of conjugated double bond. Results showed both having approximately equal value for the final day *viz*. RBO:CO (60:40) 0.71, RBO:CO (40:60) 0.79. Peroxide value of RBO:CO (40:60) showed a tremendous decrease from day 1 to day 5 (Table-3) and final day value obtained as 4.87 mequiv/Kg. In base blend it showed 9.3 mequiv/Kg in the final day. A decrease of value from 9.3 mequ/Kg to 4.87 in the blend in the RBO:CO (40:60). RBO:CO 60:40 the base blend showed 19.2 mequiv/Kg in the final day but after addition of cardamom oil it reduced to 5.2 this explain 50 % inhibition occurred.

Clove oil is added in all the blends and it was noticed RBO:CO 60:40 and 40:60 having lesser free fatty acid values throughout the study. Table-2 showed that base blend RBO:CO (40:60) having free fatty acid value 0.378 in the final day and RBO:CO (60:40) have 0.645. After adding clove oil the stability of the blends is enhanced RBO:CO (40:60) 0.378 to 0.35, RBO:CO(40:60) 0.645 to 0.49. Diene value showed almost constant value throughout the study and the final day *viz*. RBO:CO (60:40) 0.97, RBO:CO (40:60) 0.74. Peroxide value of RBO:CO (40:60) showed a tremendous decrease from day 1 to day 5 (Table-3) when compared to base blend (Table-2) RBO:CO 40:60 9.3 to 7.2 and base blend RBO:CO 60:40 19.2 to 8.6 mequiv/Kg.

Paprika oil added blends noticed that free fatty acid value obtained in base blends is higher than in the paprika oil added blends from day 1 to the final day, the values are almost constant and reached 0.37, 0.26 for the samples RBO:CO 60:40 and RBO:CO 40:60 respectively. Table-2 showed that blend RBO:CO (40:60) having free fatty acid value 0.378 for the final day and RBO:CO (60:40) having 0.645 so paprika oil added free fatty acid value is reduced. Diene value of the sample where *viz.* RBO:CO (60:40) 0.80, RBO:CO (40:60) 0.74. Peroxide value of RBO:CO (40:60) showed a tremendous decrease from day 1 to day 5 (Table-3) in paprika oil added blend. It showed 9.3 mequiv/Kg in the final day but after adding paprika oil it reduced to 5.62. In the blend RBO:CO 60:40.

TABLE-3
STABILITY STUDIES OF EDIBLE OIL BLENDS ADDED WITH SPICE EXTRACT OF FLAVOUR

		Free fatty acid value					Peroxide value					Diene value				
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 1	Day 2	Day 3	Day 4	Day 5	Day 1	Day 2	Day 3	Day 4	Day 5
RBO:CO																
Cardamom oil	RBO(60):CO(40)	0.66 ± 0.11	0.75 ± 0.13	0.65 ± 0.12	0.474 ± 0.22	0.39 ± 0.21	2.86 ± 0.21	4.4 ± 0.15	4.14 ± 0.14	7.04 ± 0.32	9.2 ± 0.43	0.86 ± 0.27	0.992 ± 0.29	0.89 ± 0.43	0.74 ± 0.54	0.71 ± 0.52
	RBO(40):CO(60)	0.75 ± 0.17	0.58 ± 0.29	0.361 ± 0.36	0.34 ± 0.45	0.39 ± 0.54	1.97 ± 0.23	2.08 ± 0.51	2.95 ± 0.27	3.65 ± 0.33	4.87 ± 0.22	0.98 ± 0.31	0.93 ± 0.10	0.87 ± 0.16	0.81 ± 0.14	0.79 ± 0.15
Clove oil	RBO(60):CO(40)	0.56 ± 0.12	0.94 ± 0.23	0.75 ± 0.53	0.65 ± 0.15	0.49 ± 0.24	3.3 ± 0.43	3.74 ± 0.22	4.14 ± 0.11	5.94 ± 0.77	7.2 ± 0.11	1.35 ± 0.22	1.2 ± 0.23	1.12 ± 0.33	1.07 ± 0.14	0.97 ± 0.22
	RBO(40):CO(60)	0.85 ± 0.44	0.52 ± 0.41	0.65 ± 0.23	0.57 ± 0.33	0.35 ± 0.42	2.68 ± 0.34	3.98 ± 0.53	4.87 ± 0.23	6.4 ± 0.54	8.6 ± 0.26	0.84 ± 0.22	0.81 ± 0.34	0.80 ± 0.53	0.80 ± 0.25	0.74 ± 0.02
Paprika oil	RBO(60):CO(40)	0.85 ± 0.01	0.62 ± 0.05	0.56 ± 0.17	0.47 ± 0.18	0.37 ± 0.08	1.87 ± 0.19	0.88 ± 0.03	1.32 ± 0.25	1.1 ± 0.05	1.32 ± 0.06	0.992 ± 0.08	0.91 ± 0.19	0.87 ± 0.11	0.85 ± 0.18	0.80 ± 0.19
	RBO(40):CO(60)	0.58 ± 0.14	0.47 ± 0.07	0.47 ± 0.04	0.38 ± 0.27	0.26 ± 0.18	2.10 ± 0.44	2.67 ± 0.24	3.40 ± 0.55	4.98 ± 0.26	5.62 ± 0.45	0.98 ± 0.36	0.92 ± 0.42	0.79 ± 0.14	0.81 ± 0.11	0.74 ± 0.28
RBO:OO																
Cardamom oil	RBO(60):OO(40)	0.56 ± 0.67	0.37 ± 0.27	0.47 ± 0.35	0.47 ± 0.15	0.28 ± 0.09	6.38 ± 0.54	5.73 ± 0.25	5.5 ± 0.36	5.94 ± 0.25	8.8 ± 0.46	1.40 ± 0.65	1.37 ± 0.87	1.29 ± 0.54	1.17 ± 0.65	1.06 ± 0.18
	RBO(40):OO(60)	0.59 ± 0.11	0.56 ± 0.22	0.49 ± 0.53	0.36 ± 0.26	0.29 ± 0.63	2.3 ± 0.86	2.6 ± 0.25	4.7 ± 0.15	7.9 ± 0.87	11.2 ± 0.56	0.94 ± 0.36	0.86 ± 0.86	0.82 ± 0.11	0.80 ± 0.22	0.76 ± 0.34
Clove oil	RBO(60):OO(40)	0.47 ± 0.23	0.61 ± 0.16	0.47 ± 0.86	0.37 ± 0.44	0.28 ± 0.25	4.84 ± 0.14	5.98 ± 0.45	4.98 ± 0.65	6.6 ± 0.87	6.6 ± 0.10	1.45 ± 0.32	1.38 ± 0.64	1.32 ± 0.87	1.27 ± 0.24	1.06 ± 0.56
	RBO(40):OO(60)	0.61 ± 0.76	0.57 ± 0.34	0.51 ± 0.15	0.42 ± 0.18	0.37 ± 0.14	5.92 ± 0.23	4.61 ± 0.08	6.3 ± 0.78	7.41 ± 0.05	9.9 ± 0.75	0.98 ± 0.87	0.94 ± 0.33	0.90 ± 0.13	0.88 ± 0.23	0.82 ± 0.66
Paprika oil	RBO(60):OO(40)	0.81 ± 0.43	0.91 ± 0.63	0.75 ± 0.15	0.37 ± 0.45	0.47 ± 0.11	4.1 ± 0.23	4.4 ± 0.14	4.18 ± 0.11	2.86 ± 0.12	1.1 ± 0.06	1.46 ± 0.15	1.41 ± 0.27	1.37 ± 0.75	1.49 ± 0.55	1.20 ± 0.65
	RBO(40):OO(60)	0.56 ± 0.16	0.64 ± 0.45	0.51 ± 0.95	0.34 ± 0.54	0.26 ± 0.15	6.02 ± 0.02	3.87 ± 0.32	6.61 ± 0.74	7.8 ± 0.33	10.3 ± 0.43	0.81 ± 0.66	0.79 ± 0.26	0.74 ± 0.25	0.71 ± 0.36	0.67 ± 0.76
SSO:SO																
Cardamom oil	SO(80):SSO(20)	0.56 ± 0.97	0.42 ± 0.15	0.47 ± 0.64	0.28 ± 0.041	0.18 ± 0.97	1.76 ± 0.67	1.98 ± 0.94	2.2 ± 0.054	2.86 ± 0.96	2.86 ± 0.04					
	SO(20):SSO(80)	1.35 ± 0.78	1.03 ± 0.04	0.86 ± 0.55	0.75 ± 0.48	0.61 ± 0.09	1.73 ± 0.67	2.1 ± 0.54	2.76 ± 0.23	1.98 ± 0.93	3.5 ± 0.18					
Clove oil	SO(80):SSO(20)	0.56 ± 0.34	0.47 ± 0.56	0.37 ± 0.87	0.37 ± 0.67	0.47 ± 0.37	1.96 ± 0.78	1.76 ± 0.92	1.76 ± 0.71	1.98 ± 0.57	1.54 ± 0.64					
	SO(20):SSO(80)	1.17 ± 0.74	0.97 ± 0.91	0.69 ± 0.67	0.71 ± 0.016	0.52 ± 0.37	2.24 ± 0.63	3.5 ± 0.27	3.78 ± 0.57	3.47 ± 0.41	5.6 ± 0.57					
Paprika oil	SO(80):SSO(20)	0.75 ± 0.49	1.23 ± 0.048	1.03 ± 0.97	0.84 ± 0.85	0.77 ± 0.51	1.54 ± 0.34	2.64 ± 0.74	4.4 ± 0.75	10.12 ± 0.24	13.7 ± 0.05					
	SO(20):SSO(80)	0.98 ± 0.64	0.87 ± 0.36	0.70 ± 0.39	0.73 ± 0.47	0.64 ± 0.15	2.89 ± 0.074	2.96 ± 0.34	1.86 ± 0.97	3.70 ± 0.037	4.1 ± 0.87					

RBO = Rice bran oil; CO = Coconut oil; SSO = Sesame oil; SO = Sunflower oil; OO = Olive oil.

The base blend showed 19.2 mequiv/Kg in the final day but after addition of paprika oil it reduced to 1.32 mequiv/Kg.

RBO:OO blends: The percentage of free fatty acid and the rate of increase of free fatty acid in both the blends of cardamom oil showed a higher value from Table-2. It showed that the blend RBO:OO (40:60) having free fatty acid value 0.52 in final day and RBO:OO (60:40) having 0.50. The samples in which cardamom oil added was found to be reduced in free fatty acid formation as follows; RBO:OO (60:40), 0.28 and for RBO:OO (40:60) was 0.29. Diene values of the samples were *viz*. RBO:OO (60:40) 1.06, RBO:OO (40:60) 0.76 in the final day. Peroxide value of RBO:OO (40:60) showed a tremendous decrease from day 1 to day 5 (Table-3). In base blend it showed 21.3 mequiv/Kg in the final day but after adding cardamom oil it reduced to 11.2 mequiv/Kg. In the blend RBO:OO (60:40) the base blend showed 20.7 mequiv/Kg in the final day but after addition of cardamom oil it reduced to 8.8 mequiv/Kg. This explains natural extracts can stabilize the blend more effectively.

In case of free fatty acid value of clove oil added blends, the percentage of free fatty acid decreased. In RBO:OO 60:40 it reached 0.52 in base blend but reduced to 0.28 clove oil added blend. Similarly RBO:OO 40:60 the value reduced from 0.5 (base blend) to 0.37 (spice added). Diene value of the present analysis showed values as follows *viz.* RBO:OO (60:40) 1.06, RBO:OO (40:60) 0.82. Peroxide value of RBO:OO (40:60) showed a tremendous decrease from day 1 to day 5 (Table-3). In base blend it showed 21.3 mequiv/Kg of peroxide value on final day but after adding clove oil it reduced to 7.41 mequiv/Kg. In the blend RBO:OO, 60:40 the base blend showed 20.7 mequiv/Kg in the final day but after addition of clove oil it reduced to 6.6 mequiv/Kg.

It showed that blend RBO:OO (40:60) having free fatty acid value 0.50 for the final day and RBO:OO (60:40) having 0.52. So paprika oil added sample have lower free fatty acid value. Free fatty acid value reduced in RBO:OO (60:40) as 0.47 and for RBO:OO (40:60) as 0.26. Diene value of the sample where *viz*. RBO:OO (60:40) 1.20, RBO:OO (40:60) 0.67. Peroxide value of RBO:OO (40:60) showed a tremendous decrease from day 1 to day 5 (Table-3). In base blend it showed 21.3 mequiv/Kg in the final day but after adding paprika oil it reduced to 10.3 mequiv/Kg. In the blend RBO:OO 60:40 the base blend showed 20.7 mequiv/Kg in the final day but after addition of paprika oil it reduced to 1.1 mequiv/Kg.

Stability studies of sesame oil and sunflower oil blends: The percentage of free fatty acid and the rate of increase of free fatty acid in both the base blends of cardamom oil showed a higher value. Table-2 showed that the blend SO:SSO (20:80) having free fatty acid value 1.43 in final day and SO:SSO (80:20) having 1.43. The samples in which cardamom oil added was found to be reduced in free fatty acid formation as follows; SO:SSO (80:20), 0.56 to 0.18 and for SO:SSO (20:80) 1.35 to 0.61. Peroxide value of SO:SSO (80:20) showed a decrease from day 1 to day 5 (Table-3). In base blend it showed 3.61 mequiv/Kg in the final day but after adding cardamom oil it reduced to 2.86 mequiv/Kg. In the blend SO:SSO (20:80) the base blend showed 3.35 mequiv/Kg in the final day but after addition of cardamom oil it increased to 3.5 mequiv/Kg.

The blends SO:SSO (80:20) has higher decrease in free fatty acid. Table-2 showed that the blend SO:SSO (80:20) having free fatty acid value 1.43 in final day and SO:SSO (20:80) have 1.42 in the base blend. The samples in which clove oil added was found to be reduced in free fatty acid formation as follows; SO:SSO (80:20), 0.47 and for SO:SSO (20:80) was 0.52. Peroxide value of SO:SSO (80:20) showed a increase from day 1 to day 5 (Table-3) in base blend it showed 3.61 mequiv/Kg in the final day but after adding clove oil it reduced to 1.54 mequiv/Kg. In the blend SO:SSO (20:80) the base blend showed 3.35 mequiv/Kg in the final day but after addition of clove oil it increased to 5.6 mequiv/Kg.

Among cardamom oil, clove oil and paprika oil added in blends of SO:SSO (80:20) and SO:SSO (20:80), cardamom oil added SO:SSO (80:20) has higher decrease in free fatty acid and peroxide value. Table-3 showed that the blend SO:SSO (80:20) having free fatty acid value 0.77 in final day and SO:SSO (20:80) have 0.64. Peroxide value of SO:SSO (80:20) showed a increase from day 1 to day 5 (Table-3) and reaches a maximum value of 13.7 mequiv/Kg and in base blend it showed 3.61 mequiv/Kg in the final day. In the blend SO:SSO (20:80) the base blend showed 3.35 mequiv/Kg in the final day but after addition of paprika oil it increased to 4.1 mequiv/Kg.

Stability studies of oleoresin added blends constituting pungency

RBO:CO: From the analysis of blends without adding extract RBO:CO (60:40) and (40:60) showed medium values of free fatty acid and peroxide values which gives evidence that the stability can be enhanced by adding spice oleoresin extract. The spice extracts added in the oil blends enhanced both physical as well as chemical properties. The percentage of free fatty acid decreased after adding ginger oleoresin. Table-2 showed that the blend RBO:CO (40:60) having free fatty acid value 0.378 for the final day and RBO:CO (60:40) have 0.645. Ginger oleoresin added free fatty acid value reduced. Diene value measures the formation of conjugated double bond from the present analysis both having approximately equal value for the final day *viz.* RBO:CO (60:40) 0.85, RBO:CO (40:60) 0.81. Peroxide value of RBO:CO (40:60) showed decrease from day 1 to day 5 (Table-4) in base blend it showed 9.3 mequiv/Kg in the final day but after adding ginger oleoresin it reduced to 4.52 in the blend RBO:CO 40:60. The base blend showed 19.2 mequiv/Kg in the final day but reduced to 1.32 mequiv/Kg in RBO:CO 60:40.

In case of free fatty acid value of black pepper oleoresin added blends, the percentage of free fatty acid rate decreased in both black pepper oleoresin added blends. It showed that base blend RBO:CO (40:60) having free fatty acid value 0.27 for the final day and RBO:CO (60:40) having 0.62 is reduced after adding black pepper oleoresin. Diene value of the sample where *viz*. RBO:CO (60:40) 0.75, RBO:CO (40:60) 0.76. Peroxide value of RBO:CO (40:60) showed a tremendous decrease from day 1 to days 5 (Table-4) in base blend it showed 9.3 mequiv/Kg in the final day but after adding black pepper oleoresin it reduced to 5.6. In the blend RBO:CO 60:40 the base blend showed 19.2 mequiv/Kg in the final day but after

TABLE-4
STABILITY STUDIES OF EDIBLE OIL BLENDS ADDED WITH SPICE EXTRACT FAVOURING PUNGENCY

		Free fatty acid value					Peroxide value					Diene value				
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 1	Day 2	Day 3	Day 4	Day 5	Day 1	Day 2	Day 3	Day 4	Day 5
RBO:OO																
Ginger oleoresin	RBO(60):OO(40)	1.61 ± 0.15	1.13 ± 0.14	0.75 ± 0.11	0.66 ± 0.10	0.47 ± 0.23	2.2 ± 0.43	7.42 ± 0.25	15.84 ± 0.61	22.44 ± 0.25	28.38 ± 0.33	1.32 ± 0.02	1.34 ± 0.05	1.45 ± 0.29	1.48 ± 0.15	1.28 ± 0.11
	RBO(40):OO(60)	1.48 ± 0.24	1.23 ± 0.36	0.89 ± 0.18	0.67 ± 0.24	0.56 ± 0.32	2.8 ± 0.26	6.7 ± 0.53	8.92 ± 0.27	9.86 ± 0.26	11.3 ± 0.53	1.0 ± 0.27	0.96 ± 0.26	0.88 ± 0.52	0.87 ± 0.42	0.77 ± 0.14
Black pepper oleoresin	RBO(60):OO(40)	1.23 ± 0.15	0.75 ± 0.25	0.85 ± 0.10	0.75 ± 0.20	0.56 ± 0.30	1.75 ± 0.26	5.5 ± 0.27	13.64 ± 0.29	20.9 ± 0.15	24.86 ± 0.26	1.15 ± 0.57	1.12 ± 0.75	1.9 ± 0.36	1.34 ± 0.43	1.27 ± 0.10
	RBO(40):OO(60)	0.98 ± 0.05	0.87 ± 0.02	0.65 ± 0.39	0.57 ± 0.18	0.36 ± 0.38	2.6 ± 0.29	2.93 ± 0.35	5.68 ± 0.18	10.6 ± 0.54	17.9 ± 0.10	0.94 ± 0.24	0.87 ± 0.87	0.69 ± 0.96	0.66 ± 0.35	0.61 ± 0.65
Paprika oleoresin	RBO(60):OO(40)	0.94 ± 0.25	1.05 ± 0.53	0.75 ± 0.36	0.75 ± 0.45	0.85 ± 0.25	1.76 ± 0.33	6.82 ± 0.27	19.8 ± 0.54	18.92 ± 0.65	29.04 ± 0.24	1.43 ± 0.15	1.37 ± 0.33	1.04 ± 0.44	0.982 ± 0.25	0.966 ± 0.15
	RBO(40):OO(60)	1.23 ± 0.36	0.87 ± 0.86	0.64 ± 0.34	0.59 ± 0.67	0.31 ± 0.35	2.65 ± 0.36	4.9 ± 0.77	5.67 ± 0.87	12.6 ± 0.54	18.6 ± 0.80	1.03 ± 0.76	0.95 ± 0.16	0.91 ± 0.05	0.87 ± 0.35	0.76 ± 0.27
RBO:CO																
Ginger oleoresin	RBO(60):CO(40)	0.56 ± 0.67	0.56 ± 0.75	0.46 ± 0.32	0.35 ± 0.91	0.28 ± 0.64	1.76 ± 0.34	0.88 ± 0.85	1.1 ± 0.47	0.66 ± 0.67	1.32 ± 0.87	1.53 ± 0.06	1.40 ± 0.25	1.36 ± 0.70	1.38 ± 0.85	0.859 ± 0.39
	RBO(40):CO(60)	0.47 ± 0.37	0.46 ± 0.15	0.39 ± 0.64	0.29 ± 0.48	0.26 ± 0.06	2.51 ± 0.58	2.98 ± 0.67	3.34 ± 0.48	4.52 ± 0.34	5.6 ± 0.78	1.25 ± 0.58	1.16 ± 0.05	0.997 ± 0.35	0.875 ± 0.77	0.816 ± 0.18
Black pepper oleoresin	RBO(60):CO(40)	1.13 ± 0.42	0.66 ± 0.18	0.85 ± 0.67	0.75 ± 0.31	0.62 ± 0.97	1.32 ± 0.25	1.1 ± 0.34	0.88 ± 0.17	0.88 ± 0.94	1.1 ± 0.40	1.01 ± 0.67	1.21 ± 0.67	1.62 ± 0.047	1.13 ± 0.63	0.759 ± 0.24
	RBO(40):CO(60)	0.42 ±	0.42 ± 0.64	0.37 ± 0.27	0.26 ± 0.42	0.27 ± 0.97	2.62 ± 0.97	3.87 ± 0.38	2.86 ± 0.96	4.42 ± 0.57	5.6 ± 0.01	0.99 ± 0.31	0.94 ± 0.06	0.91 ± 0.87	0.88 ± 0.18	0.76 ± 0.67
Paprika oleoresin	RBO(60):CO(40)	0.85 ± 0.38	0.75 ± 0.15	0.75 ± 0.47	0.75 ± 0.37	0.62 ± 0.74	1.54 ± 0.04	0.88 ± 0.77	1.32 ± 0.89	0.88 ± 0.78	1.1 ± 0.64	1.48 ± 0.97	1.47 ± 0.34	1.17 ± 0.52	1.34 ± 0.95	1.23 ± 0.34
	RBO(40):CO(60)	0.39 ± 0.69	0.48 ± 0.74	0.34 ± 0.15	0.26 ± 0.09	0.23 ± 0.62	1.97 ± 0.07	2.63 ± 0.09	2.97 ± 0.67	3.87 ± 0.48	4.5 ± 0.28	0.81 ± 0.38	0.77 ± 0.47	0.76 ± 0.98	0.81 ± 0.19	0.70 ± 0.95
SSO:SO																
Ginger oleoresin	SO(80):SSO(20)	1.42 ± 0.078	1.23 ± 0.56	0.84 ± 0.24	0.56 ± 0.48	0.41 ± 0.97	0.88 ± 0.74	1.32 ± 0.75	2.64 ± 0.69	4.62 ± 0.04	5.7 ± 0.89					
	SO(20):SSO(80)	1.08 ± 0.78	0.96 ± 0.34	0.81 ± 0.94	0.62 ± 0.34	0.37 ± 0.87	1.68 ± 0.078	2.3 ± 0.04	1.89 ± 0.047	2.63 ± 0.48	3.1 ± 0.68					
Black pepper oleoresin	SO(80):SSO(20)	0.85 ± 0.74	0.75 ± 0.054	0.65 ± 0.04	0.56 ± 0.64	0.42 ± 0.75	1.76 ± 0.06	2.76 ± 0.47	3.74 ± 0.47	7.26 ±	9.4 ± 0.57					
	SO(20):SSO(80)	0.89 ± 0.48	0.72 ± 0.97	0.56 ± 0.94	0.56 ± 0.87	0.49 ± 0.17	2.3 ± 0.84	1.9 ± 0.58	3.3 ± 0.026	3.76 ± 0.76	4.7 ± 0.25					
Paprika oleoresin	SO(80):SSO(20)	1.14 ± 0.57	1.14 ± 0.67	0.94 ± 0.15	0.75 ± 0.47	0.59 ± 0.078	1.1 ± 0.34	1.980 ± 0.76	5.06 ± 0.052	11.22 ± 0.087	12.6 ± 0.75					
	SO(20):SSO(80)	1.12 ± 0.01	1.03 ± 0.74	0.91 ± 0.67	0.85 ± 0.96	0.64 ± 0.15	1.97 ± 0.89	2.64 ± 0.41	2.78 ± 0.087	3.98 ± 0.57	4.12 ± 0.24					

RBO = Rice bran oil; CO = Coconut oil; SSO = Sesame oil; SO = Sunflower oil; OO = Olive oil.

addition of black pepper oleoresin it reduced to 1.1. From Tables 2 and 4, it showed that blend RBO:CO (40:60) having free fatty acid value 0.23 for the final day and RBO:CO (60:40) having 0.62 after adding paprika oleoresin free fatty acid value is reduced. Diene value of the sample where *viz.* RBO:CO (60:40) 1.23, RBO:CO (40:60) 0.70. Peroxide value of RBO:CO (40:60) showed a tremendous decrease from day 1 to day 5 (Table-4) in base blend it showed 9.3 mequiv/Kg in the final day but after adding paprika oleoresin it reduced to 4.5. In the blend RBO:CO 60:40 the base blend showed 19.2 mequiv/Kg in the final day but after addition of paprika oleoresin it reduced to 1.1 mequiv/Kg.

RBO:OO: Table-2 showed that the blend RBO:OO (40:60) having free fatty acid value 0.50 in final day and RBO:OO (60:40) having 0.52. The free fatty acid of samples in which ginger oleoresin added was found to be reduced in RBO:OO (60:40), 0.47 and in RBO:OO (40:60) it is increased to 0.56. Diene values of the samples were *viz.* RBO:OO (60:40) 1.28, RBO:OO (40:60) 0.77 in the final day. Peroxide value of RBO:OO (40:60) showed a tremendous decrease from day 1 to day 5 (Table-4) in base blend it showed 21.3 mequiv/Kg in the final day but after adding ginger oleoresin it is decreased to 11.3 mequiv/Kg. In the blend RBO:OO (60:40) the base blend showed 20.7 mequiv/Kg in the final day but after addition of ginger oleoresin it increased to 28.38 mequiv/Kg.

Table-2 showed that the blend RBO:OO (40:60) having free fatty acid value 0.50 in final day and RBO:OO (60:40) having 0.52. The samples in which black pepper oleoresin added was found to be increase in RBO:OO (60:40) increases from 0.52 to 0.56 and reduces from 0.5 to 0.36 in the case of RBO:OO (40:60). Diene values of the samples were *viz.* RBO:OO (60:40) 1.27, RBO:OO (40:60) 0.61 in the final day. Peroxide value of RBO:OO (40:60) showed a tremendous increase from day 1 to day 5 (Table-4) in base blend it showed 21.3 mequiv/Kg in the final day but after adding black pepper oleoresin it decreased to 17.9 mequiv/Kg. In the blend RBO:OO (60:40) the base blend showed 20.7 mequiv/Kg in the final day but after addition of black pepper oleoresin it increased to 24.86 mequiv/Kg.

The percentage of free fatty acid and the rate of increase of free fatty acid in both the blends of paprika oleoresin showed a higher value. Table-2 showed that the blend RBO:OO (40:60) having free fatty acid value 0.50 in final day and RBO:OO (60:40) having 0.52. The samples in which paprika oleoresin added was found to be increase to 0.85 in RBO:OO (60:40) and reduces for RBO:OO (40:60) as 0.31. Diene values of the samples were *viz*. RBO:OO (60:40) 0.96, RBO:OO (40:60) 0.76 in the final day. Peroxide value of RBO:OO (40:60) showed a tremendous increase from day 1 to day 5 (Table-4) in base blend it showed 21.3 mequiv/Kg in the final day but after adding paprika oleoresin it decreased to 18.60 mequiv/Kg. In the blend RBO:OO (60:40) the base blend showed 20.70 mequiv/Kg in the final day but after addition of paprika oleoresin it increased to 29.04 mequiv/Kg.

Sunflower oil and sesame oil: The percentage of free fatty acid and the rate of increase of free fatty acid in both the blends of ginger oleoresin showed a higher value. Table-2 showed that the blend SO:SSO (80:20) having free fatty acid value 1.43 in final day and SO:SSO (20:80) having 1.42. The samples in which ginger oleoresin added was found to be reduced in free fatty acid as follows; SO:SSO (80:20), 0.41 and for SO:SSO (20:80) as 0.37. Peroxide value of SO:SSO (80:20) showed a tremendous decrease from day 1 to day 5 (Table-4) in base blend it showed 3.61 mequiv/Kg in the final day but after adding ginger oleoresin it increase to 5.7 mequiv/Kg. In the blend SO:SSO (20:80) the base blend showed 3.35 mequiv/Kg in the final day but after addition of ginger oleoresin it reduced to 3.1 mequiv/Kg.

Pepper oleoresin added sample showed a higher value. Table-2 showed that the base blend SO:SSO (80:20) having free fatty acid value 1.43 in final day and SO:SSO (20:80) having 1.42. The samples in which Black pepper oleoresin added was found to be reduced in free fatty acid formation as follows; SO:SSO (80:20), 0.42 from 1.43 and for SO:SSO (20:80) 0.49 from 1.42. Peroxide value of SO:SSO (80:20) showed a tremendous increase from day 1 to day 5 (Table-4). In base blend it showed 3.61 mequiv/Kg in the final day but after adding black pepper oleoresin it increase to 9.4 mequiv/Kg. In the blend SO:SSO (20:80) the base blend showed 3.35 mequiv/Kg in the final day but after addition of Black pepper oleoresin it increase to 4.7 mequiv/Kg.

Paprika oleoresin addition to SO:SSO (80:20) having free fatty acid value 1.43 in final day and SO:SSO (20:80) having 1.42. The samples in which paprika oleoresin added was found to be reduced in free fatty acid formation as follows; SO:SSO (80:20), 0.59 and for SO:SSO (20:80) was 0.64. Peroxide value of SO:SSO (80:20) showed a tremendous increase from day 1 to day 5 (Table-4). In base blend, it showed 3.61 mequiv/Kg in the final day but after adding paprika oleoresin it increased to 12.6 mequiv/Kg. In the blend SO:SSO (20:80) the base blend showed 3.35 mequiv/Kg in the final day but after addition of paprika oleoresin it increase to 4.12 mequiv/Kg.

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