

Edible Oils Nutrition Status Assessment

Anjali Devi C¹, Anish Rithvik Kothuri²

Professor Department of Food & Nutrition, Osmania University, India
Student 12th Grade, Claudia Taylor Johnson HS, TX, USA

Abstract: Consumption of edible oils and its influence on health parameters was studied among 320 families in Hyderabad. Information on the type of oils and number of edible oils consumed by each family was collected using a pretested schedule. Health parameters identified for comparison are - Height, weight, systolic, diastolic pressure and fasting blood glucose. Samples were collected using standard procedures, Age of the participants ranged between 20 to 80 years. Families selected oils from eleven different refined oils, palm oil and three unrefined oils. Comparison of health parameters is made between the users of only edible refined oils, refined and palm oil, only palm oil and only unrefined oil users. Significant differences existed between various oil users. The differences between unrefined oil users and those using only palm oil were significantly different. Normal BMI was 56.3 percent among unrefined oil users while it is only 2.5 percent among the palm oil was 50 percent users. Obesity percent was as high as 95 percent among palm oil users while it is 18.7 percent among the unrefined oil group. Normal systolic pressure among unrefined oil users was 50 percent while it is 2.5 percent among palm oil users; normal diastolic pressure was recorded in 50 percent and 5 percent among unrefined oil and palm oil users respectively. In the category of fasting blood glucose, normal levels among unrefined oil users were higher (43.8) compared to 2.5 percent among palm oil users. Confirmed diabetics are 18.7 percent in the unrefined oil group, while it is 95 percent in the palm oil user group. Results have indicated that those using cold pressed unrefined oils have significantly better health status as judged by BMI, Systolic and diastolic pressure, and fasting blood glucose levels compared to palm oil group, among the refined oil consumer group, the values were in between the unrefined oil users and the palm oil users.

Keywords: Cold Pressed oils, palm oil, refined oil, health parameters

1. Introduction

Edible oils play an important role in the causation, treatment, management and prevention of coronary heart diseases. Right selection of edible oil is important in Indian context. As Indian cooking, subjects oil to high temperatures like in deep fat frying which raises temperature up to 170⁰ C, use of refined oils can degrade to toxic components like free radicals, trans fats etc. at high temperatures (1, 2).

Edible oil consumption pattern in India is fast changing in the recent past due to socio - economic and policy changes. More changes are occurring in the fast growing states, Telangana being one of them. Factors contributing to these changes are urbanization, changing lifestyles, availability of oils in packed form, changes in prices of oils, oil supplied through PDS at low cost, increased income levels of rural and urban households and edible oils being marketed with a host of health claims (3) There has been a perceptible shift in edible oil consumption from traditional groundnut oil and cold pressed oils to other refined edible oils (4). Vizag study described the effect of covid 19 lockdowns as it resulted in the family members staying at home coupled with online purchases of food contributed to erratic food consumption. (5)

Consumption pattern indicated that each Indian on an average consumed 14.2 kg /year /person in 2010 - 2011, 15.8 kg in 2012 - 2013 and 19.5 kg of edible oil as per 2015 - 2016 statistics. As per ICMR_NIN dietary guidelines 15 - 30 percent of calories should come from fat i. e. 29 grams/person/day, the calculation comes to 10.585 kilograms /person/year (6, 7). Excess consumption can lead to obesity, cardiovascular diseases and diabetes (8). According to Cardio vascular diseases report by WHO among Non - communicable diseases, Cardio vascular diseases are the main reason for deaths in India. Cardio

vascular diseases are also affecting younger age groups in India compared to developed countries with 52 percent of deaths due to CVDs below the age of 70 in India compared to 23 percent in developed countries. The causes are reported to the use of type of fats and oils. (6, 9, 10).

Cold pressed oils are considered as a healthy method of processing, since they are not subjected to any kind of external heat therefore they retain nutritive value, flavor, aroma, have anti - inflammatory and healing properties, preservatives or chemicals are not added and they do not leave any harmful solvent residues (11). Refining of oils involves crushing, oil extraction, steaming, bleaching, filtration, deodorization, inactivation of metals. Refining vegetable oils damages fats, makes oils unstable. Artery cloggers are more in refined unsaturated and polyunsaturated fats. Trans fats in fried and processed foods risk for type II diabetes, lowers HDL. Therefore, use of a combination of unrefined oils are recommended (12). It was reported that for every kilogram of palm oil (refined) consumed per capita annually leads to ischemic heart disease, with mortality rates being 68 /1, 00, 000 in developing countries. Just replacing with indigenous oil shall, not only save lives but also reduces over all medical costs. (13), Palm oil being cheapest is widely used by commercial establishments. Prevalence of overweight/ obesity was lower in mustard oil consumption compared to refined and other oils. Groundnut oil (unrefined) showed no association with overweight or obesity (14). Coconut oil consumption resulted in higher LDC compared to vegetable oils. (15) Studies on consumption pattern of oils in relation to health status after lockdown are scanty. The present study concentrates on oil consumption pattern and its relation to weight and other health parameters after the pandemic lockdowns - the **NEW NORMAL**

2. Methods and Materials

The fast rising incidence of obesity and related non-communicable diseases in urban areas prompted to study the influence of different oils on health status of adults in Hyderabad city. As part of International Women's Day celebrations organized a utility camp to study the edible oil consumption pattern. Six hundred people from various parts of the city attended the program. Of them 320 people agreed to participate in a detailed survey. A schedule was prepared to elicit information on the consumption pattern of oils and the perception of health benefits. Health status was assessed using BMI, systolic and diastolic pressure and fasting blood glucose levels. Height was recorded using anthropometric rod, weight was taken using a lever balance. Blood Pressure was recorded using sphygmomanometer. Fasting blood glucose level was done by the pinprick method. Market survey was done to identify the different oils sold in the market, and the fast selling oils. A pre-tested schedule was used to collect information on the oils used. Standards followed for various health parameters are given below:

Health Parameter	Levels	Range
Body	Normal	18.5 - 25
Mass	Overweight	25 - 30
Index	Obese	> 30 - 35
Systolic	Normal	<120
Pressure	Elevated	120 - 129
mmHg	High I	130 - 139
	High II	>140
Diastolic	Normal	<80
Pressure	High I	80 - 89
mmHg	High II	>90
Fasting	Normal	70 - 100
Blood Sugar	Pre Diabetic	101 - 125
mg/dl	Diabetic	>126

Data is presented as percentages and Chi square values. Statistical analysis was done using SPSS package. For all tables, actual figures are given in Parenthesis.

3. Results

Consumption pattern of edible oils and its relation to Body Mass Index, Systolic and Diastolic pressure and Fasting Blood Glucose level were studied. Eleven different refined oils are consumed. They are gold drop, freedom oil, groundnut oil, sunflower oil, rice bran oil, safflower oil, gingelly oil, nature, coconut oil, refined palm oil, distributed through PDS at discounted rate **Table 1**.

Table 1: Refined Oils used by Families

Refined Oil			
No	OILS	%	No
1	Gold Drop	73.8	236
2	Freedom Oil	49.4	158
3	Ground Nut oil	30.6	98
4	Sunflower oil	7.5	24
5	Rice bran oil	3.1	10
6	Sun Drop oil	9.7	31
7	Safflola	15.0	48
8	Gingelly oil	13.1	42
9	Nature	5.6	18
10	Coconut oil	4.3	14
11	Palm oil	31.3	100

Gold drop – refined oil was largely selected as it is available with small and big vendors and is cheap, advertisements over the TV, made some people switchover to freedom oil. Other oils are selected based on the availability, cost and health claims that they hold. Three unrefined/cold pressed oils are used they are gingelly oil by 25 %, safflower oil by 21.9 % and groundnut oil by 53.6 percent (Table 2).

Table 2: Unrefined Oils used by Families

Unrefined oils			
12	Gingelly oil	25.0	8
13	Safflower oil	21.9	7
14	Ground nut oil	53.6	17

To study the impact of oils on health status, they are divided into four groups - Only refined oils grouped they constitute 58.7 percent, second group is refined oil and Palm oil (18.8%), third group is only Palm oil (12.5%) and fourth group is unrefined oil (10%). (Table 3)

Table 3: Distribution of Families among the four groups of oil users

Type of oils	%	No
Only refined oils	58.7	188
Palm oil + Refined oil	18.8	60
Only Palm Oil	12.5	40
Unrefined oil	10.0	32
Total	100	320

Majority families used only one oil, they constitute 60.6 percent. With the concept of blending oils for good health the trend of including more than one oil is reported. Families using two different oils constitute 21.1 percent and those using three different oils are 2.9 percent, whether it is one or more oils used all of them are only refined oils and 15.4 % used unrefined oil (Table 4)

Table 4: Number, Type of Oils Consumed

	No. of Refined Oils used			Un refined	Total
	1	2	3		
Percent	60.6	21.1	2.9	15.4	100
Number	214	44	30	32	320

Body Mass Index its relation to different oils used is given in Table 5. Body mass Index helps in determining health risks - overweight or obesity can lead to Diabetes mellitus, high blood pressure, cardiovascular disease, several types of cancers (breast, colon, and prostate,) high cholesterol and sleep apnea. There may be several reasons for being overweight/obese but the most important is food, especially, oil consumption pattern. In view of the increasing consumption of fast foods and increase in oil consumption, estimation of BMI is taken as a first step in determining health condition (17). Among those consuming only refined oils, 36.5 percent are under normal category, while the rest (63.5 %) are either overweight (46.2%) or obese (17.3%). In the second group, 33.3 percent are normal while the rest (66.7 %) are overweight or obese. In the palm oil consumption group only 2.5 percent have normal BMI while 97.5 percent are either overweight or obese. The group using only cold pressed, unrefined oils, 56.3 percent have normal BMI, while 25 percent are overweight and only 18.7 percent are obese. The differences are found to be significant at 1 percent level by chi square test.

Table 5: Oils used & Body Mass Index of Adults

Groups	Refined oils	Palm oil + refined oil	Palm oil	Un - refined oil	Total
Normal 18.5 - 25	36.5 (48)	33.3 (20)	2.5 (1)	56.3 (18)	27.2 (87)
Overweight 25 - 30	46.2 (32)	36.6 (22)	2.5 (1)	25 (8)	19.7 (63)
Obese >30	17.3 (108)	30.0 (18)	95 (38)	18.7 (6)	53.1 (170)
Total	100 (188)	100 (60)	100 (40)	100 (32)	100 (320)

P =.00001 p< 0.1

Normal systolic pressure was observed among 23.4 percent in the group consuming only refined oils, 4.6 percent in the group using palm oil and refined oils, among those using only palm oil the percentage is as low as 2.5 percent. Among the unrefined oil user group 50 percent are in the normal category. High systolic pressures in 95 percent in palm oil group and 81.2 percent in palm oil and other refined oils group is a matter of concern. (Table 6).

High blood pressure - systolic or diastolic is mainly due to unhealthy lifestyle choices, no regular physical activity and obesity (18). It gives no warnings; Normal systolic pressure was 23.4 percent in the group consuming only refined oils, 4.6 percent in the group using palm oil and refined oils, among those using only palm oil the percentage is as low as 2.5 percent. Among the unrefined oil user group 50 percent are in the normal category. With respect to high systolic pressure it is recorded in 95 percent of the palm oil consumer group and 81.2 percent in palm oil and other refined oils group, this is a matter of concern. (Table 6).

Table 6: Impact of Oil Consumption on Systolic Pressure

Groups Mm/Hg	Refined oils	Palm oil refined oils	Only Palm oil	Only Un refined oils	Total
Normal <120	23.4 (44)	6.3 (1)	2.5 (1)	50 (16)	34.5 (28)
Elevated 120 - 129	28.8 (38)	12.5 (11)	2.5 (1)	37.5 (12)	22.6 (49)
High 130 - 139	63.5 (106)	81.2 (48)	95.0 (38)	12.5 (4)	62.9 (131)
Total	100 (188)	100 (60)	5.0 (40)	100 (32)	100 (320)

P =.00001, p< 0.1

Diastolic pressure is normally stable; any fluctuation indicates signals of health risk. Normal diastolic pressure among those consuming refined oils, palm oil and refined oil and palm oil are 23.4, 33.3 and 5.0 percent respectively, while among those consuming unrefined oils the percentage is 50%. Systolic and diastolic levels are considered important while monitoring heart health especially among people above 50 years (19). The differences between oil user groups is significant at 1 percent level (Table 7).

Table 7: Impact of Oils used on Diastolic Pressure

Levels mm/Hg	Refined	Palm+ Refined	Palm oil	Unrefined	Total
Normal	23.4 (44)	33.3 (20)	5.0 (9)	50.0 (16)	60.7 (82)
Elevated	20.2 (38)	36.7 (22)	7.5 (30)	37.5 (12)	29.8 (75)
High level	56.4	30.0	87.5	12.5	50.9

	(106)	(18)	(1)	(4)	(163)
Total	100 (188)	100 (60)	100 (40)	100 (32)	100 (320)

P =.00001 p< 0.1

Fasting blood glucose level among persons with normal level in the palm oil group is very low (2.5%) while those using unrefined oil category is as high as 43.8 percent, although the group has 10 senior citizens (Table 8). Fasting blood glucose level, is used as a parameter to judge whether a person is diabetic or not. When fasting, the hormone glucagon is stimulated, it increases glucose levels in the body, if a patient does not have diabetes their body will produce insulin to rebalance the increased glucose levels, therefore regular testing helps to monitor the meals, physical activity and medicines (20)

Table 8: Consumption of Oils on Fasting Blood Sugar

Categories	Oils				Total
	Refined	Palm + refined	Palm oil	Unrefined	
Normal	38.8 (73)	10.0 (6)	2.5 (1)	43.8 (14)	29.4 (94)
Pre - diabetic	36.7 (69)	30.0 (18)	2.5 (1)	37.5 (12)	31.3 (100)
Diabetic	24.5 (46)	60.0 (36)	95.0 (38)	18.7 (6)	39.3 (126)
Total	100 (188)	100 (60)	100 (40)	100 (32)	100 (320)

P =.00001 p< 0.1

From Tables 9 to 16 results are presented based on impact of different oil groups and health. Parameters. BMI and fasting glucose level of refined and unrefined oils is given in Table 9. Normal BMI is recorded in 23.9 % in refined oil group while it is 56.3 % in unrefined oil group. On the other hand obese people are 56.9 percent among the refined oils user group while in the unrefined oil user group it is 18.7 percent

Table 9: BMI, Fasting Glucose Levels of Refined Vs Unrefined Oil Users

Groups	Refined* oils		Unrefined oils		
	288		32		
	%	No	%	No	
BMI	Normal	23.9	69	56.3	18
	Overweight	19.1	55	25.0	8
	Obese	56.9	164	18.7	6
P= 0.000059 Significant at p<0.01					
Fasting Blood glucose	Normal	27.7	80	43.8	14
	Prediabetes	30.5	88	37.4	12
	Diabetic	41.7	120	18.8	6
P= 0.033593 Significant at p<0.05					

* Other refined oils and palm oil included

Similar observations were recorded in fasting glucose levels. In the refined oil group, 27.7 percent are in the normal category while confirmed diabetics are 41.7 percent. In the unrefined oil user group normal are 43.8 percent and confirmed diabetics are 18.8 percent. The differences are found to be highly significant by chi square test.

Table 10: Systolic & Diastolic pressure of refined and unrefined oil users

Groups		Refined* oils		Unrefined oils	
		288		32	
		%	No	%	No
Systolic Pressure 87	Normal	4.2	44	50.0	16
	Elevated	12.8	138	37.5	12
	High	94	106	12.5	4
P= 0.000021 Significant at p<0.01					
Diastolic Pressure	Normal	22.9	66	50	16
	Elevated	21.9	63	16.0	12
	High	55.2	159	2.5	4
P= 0.000021 Significant at p<0.01					

* Other refined oils and palm oil included

High systolic and diastolic pressure individuals are significantly more in the refined oil group (94% and 55.2% respectively) as compared to unrefined oil group, 12.5 and 2.5 percent respectively. (Table10)

BMI and fasting glucose levels of refined oil group, compared with palm oil +refined oil group are indicated that the percent normal are very low they are 25.5 % and 21 percent respectively. On the contrary in the obese group the percentages are 57.4 and 56 respectively. As per fasting glucose levels, confirmed diabetics are 24.5 percent in the refined oil group and 74 percent in the palm oil group (Table 11).

Table 11: BMI & Fasting Glucose of Refined Vs Palm Oil Group

Groups		Refined oils		Palm oil +R Oils	
		188		100	
		%	No	%	No
BMI	Normal	25.5	48	21	21
	Overweight	17.0	32	23	23
	Obese	57.4	108	56	56
P=0.405469, not Significant p<0.05					
Fasting Blood Glucose	Normal	38.8	73	7	7
	Pre - diabetic	36.7	69	19	19
	Diabetic	24.5	46	74	74
P=0.00001 Significant at p<0.01					

Systolic and diastolic readings are presented in Table 12.

Table 12: Blood Pressure among Refined vs Palm Oil Group

Groups		Refined oils		Palm + Other Oils	
		188		100	
		%	No	%	No
Systolic Pressure	Normal	23.4	44	2	2
	Elevated	20.2	38	12	12
	High	56.4	106	86	86
P=0.00001 Significant at p<0.01					
Diastolic Pressure	Normal	71.3	134	34	34
	Elevated	17.5	33	59	59
	High	15.9	30	7	7
P=0.00001 Significant at p<0.01					

High systolic pressure is 56.4 and 86 percent respectively in refined and palm oil group. In the case of diastolic pressure, the percentage is relatively low; it is 15.9 and 7 respectively. The differences were found to be significant.

Tables 13 and 14 gives, the gender based analysis of families using only refined oils is presented

Table 13: Males & Females using refined oils

Groups		Only Refined oils			
		Males		Females	
		Number			
		114		74	
Groups		%	No	%	No
Body Mass Index	Normal	10.5	12	48.6	36
	Overweight	28.1	16	21.6	16
	Obese	75.3	86	29.7	22
P=0.007435 Significant at p<0.01					
Fasting Blood Glucose	Normal	28.9	33	50.1	40
	Pre - diabetic	41.2	47	29.7	22
	Diabetic	54.3	34	16.2	12
P=0.002137 Significant at p<0.01					

Body mass index indicated 48.6 percent of females under normal category and 10.5 percent are obese while in males the values are vice versa the percent obese are 75.3 and those in the normal level are. As per fasting blood glucose level, diabetics are more in males (54.3 %) than in females (16.2%).

Table 14: Blood Pressure levels of Males and Females Using refined oils

Groups		Only Refined oils			
		Males		Females	
		Number			
		114		74	
Groups		%	No	%	No
Systolic pressure	Normal	15.8	18	35.1	26
	Elevated	17.5	20	24.3	18
	High	66.6	76	40.5	30
P=0.001098 Significant at p<0.01					
Diastolic Pressure	Normal	70.2	80	72.9	54
	Elevated	21.1	24	12.2	9
	High	8.8	10	26.3	20
P=0.168541 Not Significant at p<0.05					

Blood pressure values are presented in Table 14. High systolic pressure in males is (66.6%) in females it is 40.5 % while in diastolic pressure females are more (26.3%) than males (8.8%)

After comparing and analyzing the health parameters of various oil consumer groups, and with a host of diverse research reports giving positive or negative effects on health of palm oil users, it was felt necessary to further compare the health parameters of palm oil users Either alone or in combination of other oils the results are presented in Tables 15 and 16.

Table 15: BMI and Fasting glucose of Palm oil users

Items	Groups	Only Palm Oil	Palm oil + Other Oils
		% (No)	% (No)
	Total No.	40	60
BMI	Normal	2.5 (1)	33.3 (20)
	Over weight	2.5 (1)	36.6 (22)
	Obese	95 (38)	30.0 (18)
P=0.00001 Significant at p<0.01			
Fasting Blood Glucose	Normal	2.5 (1)	10.0 (6)
	Pre diabetic	2.5 (1)	30.0 (18)
	Diabetic	95 (38)	60.0 (36)
P=0.000441 Significant at p<0.01			

All the palm oil users were using only refined palm oil, the form in which procured distributed or available and there

was not choice, those adding other oils chose only other refined oils. Among the users of only palm oil, 38 out of 40 persons are obese, while in the group that added a refined oil in addition to palm oil, obese people are only 18 out of 60 are obese, indicating that there is an indirect effect of palm oil on the weight of the person.

Fasting glucose level in the palm oil group 95 percent are diabetic, and those who added another oil to palm the percent is only 60 percent although both showed an impact.

Table 16: Blood Pressure of Palm oil users

Items	Groups	Only Palm Oil	Palm oil + Other Oils
		% (No)	% (No)
	Total No.	40	60
Systolic Pressure	Normal	2.5 (1)	1.7 (1)
	Elevated	2.5 (1)	18.3 (11)
	High	95.0 (38)	80.0 (48)
P=0.057122 Not Significant p<0.05			
Diastolic Pressure	Normal	25.0 (10)	40.0 (24)
	Elevated	72.5 (29)	50 (30)
	High	2.5 (1)	10 (6)
P=0.06154 Not Significant at p<0.05			

High Systolic pressure is recorded among 95 percent in only palm users and 80 percent in palm oil and palm oil and other oil group respectively. Similar trend is observed with diastolic group. Normal level is seen in 25 percent only palm oil group and 40 % in palm oil and refined oil group in

4. Conclusion

In all basic health parameters – Body Mass Index, fasting blood glucose level, systolic and diastolic pressure, unrefined oil users have a better health than other refined oils, the next category which better is the refined oil group the least is the palm oil user group. In all health parameters studied, significant differences existed between all refined oils and palm oil consumption.

Health status of only palm oil or palm oil with refined oil combination (Table 10 and 15, 16), showed that among only palm oil users, those in the normal category are 2.5, and 2.5, 25, and 2.5 percent with respective to BMI, systolic, diastolic pressure and fasting blood glucose level. In the palm oil+ other refined oil group, blending resulted in a better status that is 33.3, 1.7, 40 and 10 percent in the BMI, Systolic, diastolic, and fasting blood sugar levels respectively. Addition of one refined oil to palm oil category completely changed the health scenario. This again substantiates that palm oil seems to have an adverse effect on various health parameters. The suggestion is to study on a larger population for confirmation.

References

- [1] Manchanda SC, Santosh Jain Possi (Selecting Healthy edible oils in the Indian context. Indian Heart Journal 68 (4), 447 - 449.
- [2] Fullana A., Carbonell - Barrachina A. A., Sidhu S. Volatile aldehyde emissions from heated cooking

- [3] oils. *J Sci Food Agric.*2004; 84: 2015–2021. [Google Scholar]
- [4] G. Govindaraj, S. Surya Prakash, N. Sivaramane, C Sunderamoorthy, P. Murali (2012) Dynamics of household edible oil consumption in rural and urban Tamil Nadu (India). Paper Presented at the international Association of Agriculture Economists (IAAE) Triennial Conference, Brazil, 18 - 24. August 2012
- [5] avimuktesh[at]cseindia. org 2012
- [6] Santhosh Patnaik (2020) Consumption of edible goes up in Vizag thanks to new normal June 29, 2020, The Hindu
- [7] Raju chokshi (2013) Consumption of edible oils in India – paradigm shift FnB news 1st October 2013
- [8] NIN Dietary guidelines
- [9] Girish Kumar Jha, Rajini YR, Aditya KS (2021) How India can be Atmanirbhar for edible oil production. Times of India Feb 21 2021
- [10] Sonai S Anand, Cormac Hawhas, Russel J. de. souza et. al (2015) A report from the Workshop convened by world Heart Federation J. Am. Coll. Cardio: 6: 66, 141590 - 1614
- [11] Nousheen M, Nafish Firozeh Sajjadi et al (2013) Improvement of dietary oil o consumption following a community trial in a developing country. The role of translational research in health Promotion: Arya Atherosclerosis 2013, Jan 9 (1) 29 - 37
- [12] US Pal, R. K. Patra, NR Sahoo e. tal (2015) J. Food Science Tech, Effect of refining on the quality and composition of sunflower oil July 52 (7) 4613 - 4618.
- [13] Rajiv Gupta, Indu Mohan, et. al (2016) Trends in Coronary heart diseases, epidemiology in India Elsevier – Annals of global Health. Vol 82, Issue 2, 307 - 315
- [14] DM Hegde Project Director Directorate of oilseed Research Reported in avimuktesh[at]cseindia. org 2012
- [15] Rutija, Tinku Thomas, Sumathi Swaminathan, Anura V Kurpad, and Indu Mani (2020) Association between mustard oil and BMI in Indians: Published online by Cambridge University Press 16th Nov 2020.
- [16] . Nitya Neelakantam, Jouy Yi Hoong Seah Rob N Vam Dam: Effect of Coconut oil consumption on cardiovascular risk factors - A systematic review and meta - analysis of clinical trials. Free Access Research Article Vol.141, No18, Jan 13, 2020.
- [17] Hegde DM 2012, Project Director, Directorate of Oil Seed Research of India, avimuktesh[at]cse. india. org 2012
- [18] Robert H Shmeding. MD, Harvard Health Publishing June 22, 2020.
- [19] Center for Disease Control and Prevention CDC Publication June, 2021
- [20] Lewine Editor in chief Harvard Health Publishing – Feb 15, 2021
- [21] National Institute of Diabetes and Digestive and Kidney diseases. US Department of Health and Human Service 2021, healthinfo[at]niddk. nih. gov