MORINGA OLEIFERA SEED OIL

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- *1.1. Global oil situation and moringa oil*

The world demand and interest in dietary oils and fats and their nutritional compositions has been steadily increasing in recent years (Bernado-Gi, *et al.*, 2002).

Oils and fats serve as a rich source of dietary energy. They contain fatty acid components which are essential nutrients (FAO, 1978) and their functional and textural characteristics contribute to the flavor and palatability of many natural and prepared foods.

This has lead to a steady increase in the demand for functional ingredients especially those obtained by “natural” processes.

Moringa seed oil is therefore gaining grounds in the global vegetable oil industry as a high oleic acid type of oil.

This type of oil is healthier, more stable to oxidative rancidity and useful in food systems that must have a high degree of oxidative stability.

Moringa plant from which the seed oil is obtained is one of the most useful tropical trees.

1.2. THE MORINGA PLANT

• Family	- Moringaceae
• Genus	- Moringa
• Common names	- horseradish tree, drumstick tree, West India Ben tree, Never Die tree, Radish tree (Ramachandran *et al*., 1980).
• Number of species	- 14
• Most important	- *Moringa oleifera,* *M. stenopetala*
• Origin	- Sub-Himalayan tracts of the Indian subcontinent
• Occurrence, cultivation	- all over the tropics
• Growth and Size	- fast growing perennial tree, grows to 7-12m height and a diameter of 20-40 cm at chest height.

It is a multipurpose tree of significant economic importance because there are several industrial and medicinal applications and various products to be used as food and feed which can be derived from its leaves and fruits (Ramachandran et al., 1980).

It possesses many valuable properties and potential uses of great scientific interest which include

- the high protein content of the leaves, petioles and stems,
- the high protein and oil contents of the seeds,
- the large number of unique polypeptides in seeds that can bind to many moieties,

It has been found to grow to 6 – 7 m in one year in areas receiving less than 400 mm mean annual rainfall (Odee, 1998).

It can grow well and easily on hillsides and on elevations of up to 1,000 m above sea level but it is more frequently found growing on pastureland or in river basins.

Introducing moringa into a farm benefits both the owner of the farm and surrounding eco-system.

According to a Japanese study the rate of absorption or assimilation of carbon dioxide by the moringa tree is twenty times (20x) higher than that of general vegetation and fifty times (50x) higher when compared to the Japanese cedar tree (Villafuerte, and Villafurte-Abonal, 2009) .

Why Plant Trees?

A tree removes
22kg of CO_2 annually,

5 million trees removes
110million kg of CO_2 annually.

In 20years,
2.2 billion kg of CO_2
will be removed.

PLANT 5 MILLION TREES IN 10 YRS

www.5in10.org

Increasing moringa plantations from 100,000 ha to 1 million ha could potentially sequester 4 giga tonnes of CO2 annually .

In this way it is a tool for Climate change and adaptability measures; positioning the small scale farmer to play meaningful role in low carbon emission, leading better nutrition of local people and reduced poverty.

Growing more moringa will provide seeds for high quality oleic oil and also absorb more carbon dioxide from the atmosphere, limiting the world's greenhouse gas emission and slow the progress of global warming.

One of the most important industrial applications is the use of Moringa seeds for water-cleaning purpose (Kalogo et al., 2001; Broin et al., 2002).

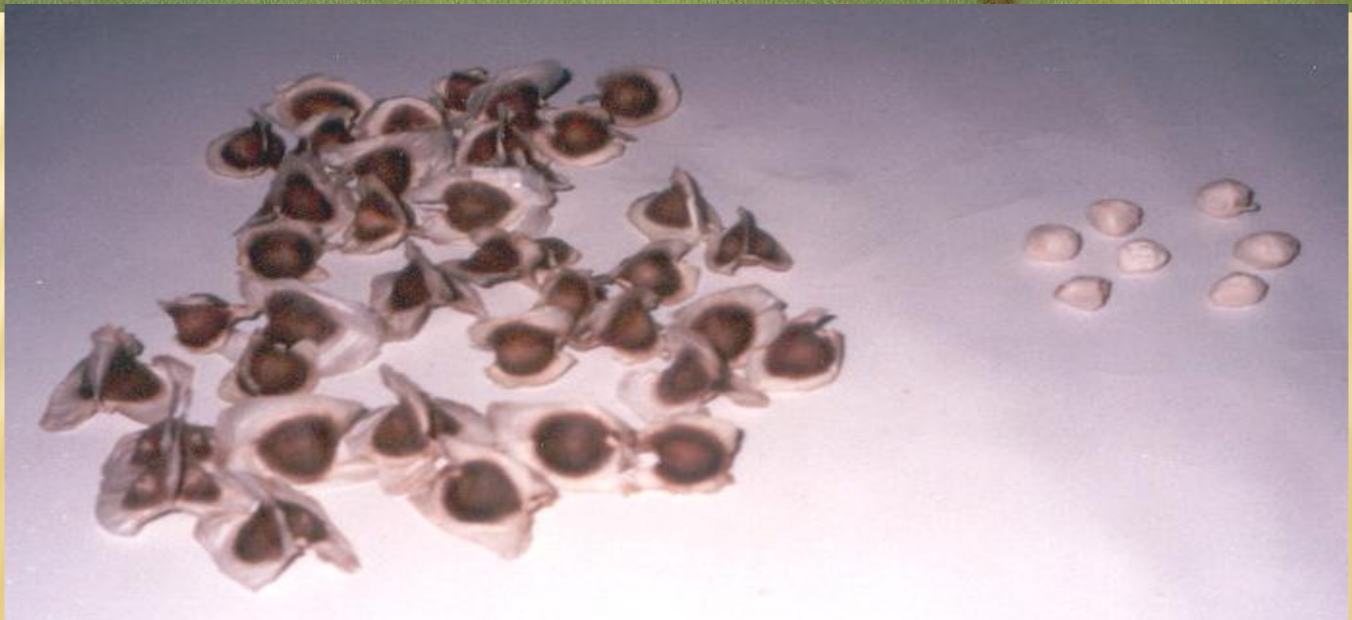
In India, the oil obtained from Moringa seeds is used for cooking and was found to contain high levels of unsaturated fatty acids (Lalas and Tsaknis, 2002).

Leaves and seeds of Moringa represent an important source of nutrients for rural populations in certain areas of India and West Africa (Gupta et al., 1989; Lockett et al., 2000).

It is widely distributed in the tropics throughout the Pacific region (Aregheore, 2002), West Africa (Freiberger et al.,1998; Lockett et al., 2000), as well as Central America and the Caribbean (Ramachandran et al., 1980; Foidl et al., 1999).

MORINGA PLANTATION

MORINGA WHOLE SEED



AVERAGE SIZE OF MORINGA SEED

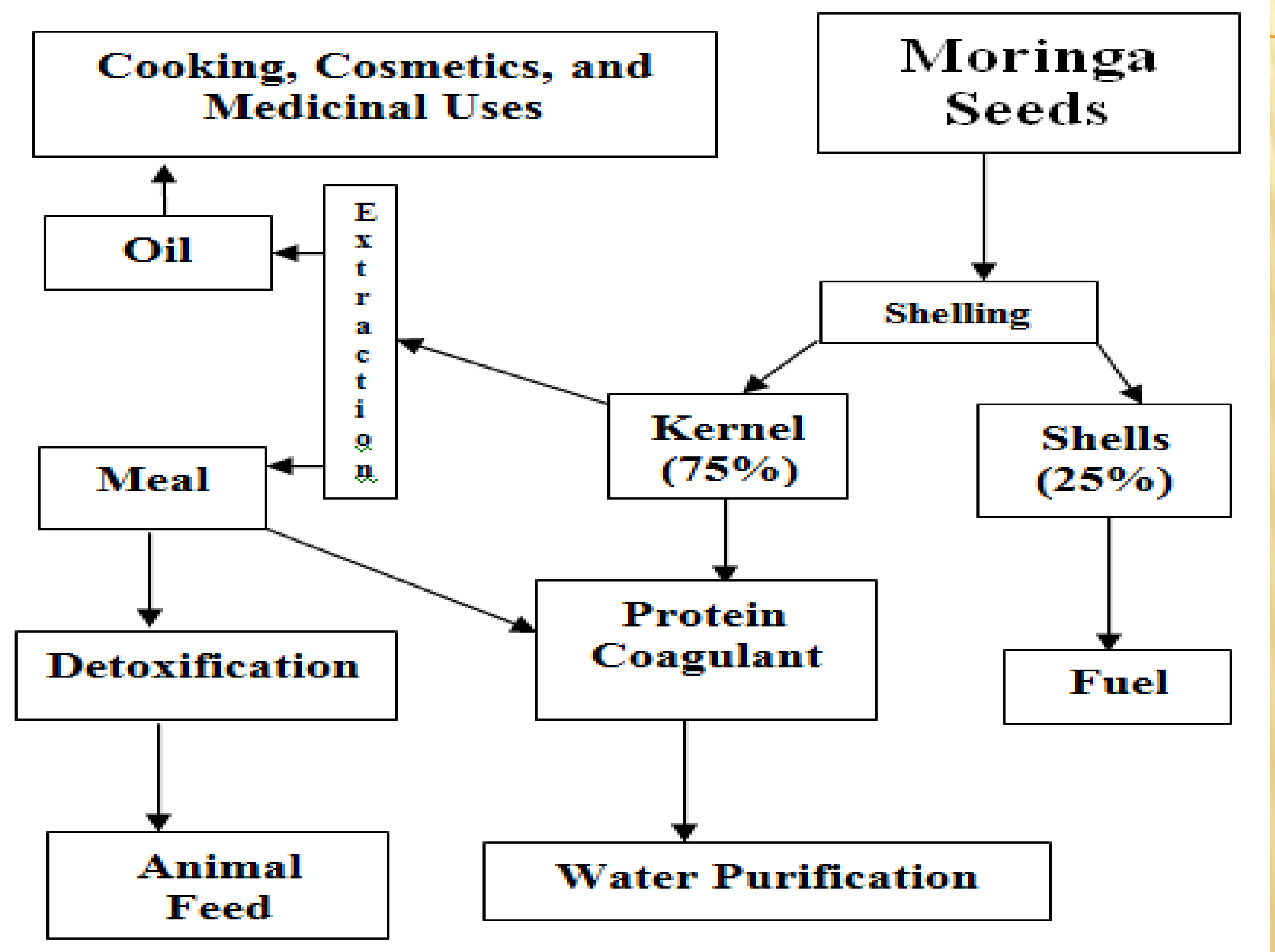
DE-SHELLED MORINGA SEED

EMPTY SHELLS OF MORINGA SEED

Physical properties of pods and seeds of Moringa

Determination	1	2	3
Average weight of pod (g)	7.60	-	7.95
Average weight of seeds (g) / pod	3.59	5.03	4.83
Average number of seeds / pod	12	17	16
Average weight (g) / 100 seeds	29.9	29.6	30.2
Average weight of kernels (g) / 100 seeds	21.2	-	22.5
Percent weight of kernel in relation to entire seed	72.5	-	74.5
Percent weight of hull in relation to entire seed	27.5	-	25.5
Moisture in kernel (%)	4.5	-	6.5
Moisture in hull (%)	9.2	-	12.9
Moisture in whole seed (%)	5.8	-	7.5

1. Ferrao and Ferrao (1970)
2. Carlos Foletti (1996; Personal communication)
3. Proyecto Biomasa (1996)


Cooking, Cosmetics, and Medicinal Uses
Moringa Seeds
Oil
Extraction
Shelling
Kernel (75%)
Shells (25%)
Meal
Protein Coagulant
Detoxification
Fuel
Animal Feed
Water Purification

MORINGA OIL (BEN OIL)

One mature moringa tree (3 years old) can produce 15,000 to 25,000 seeds per year and a plantation can produce 3000 kg of seeds per hectare.

This is equivalent to 900 kg oil per hectare (i.e. 30%) and is comparable to soybean which needs yearly cropping and yields an average of 3000 kg seeds per hectare with only 20% oil yield (Mohammed, *et al.*, (2003).

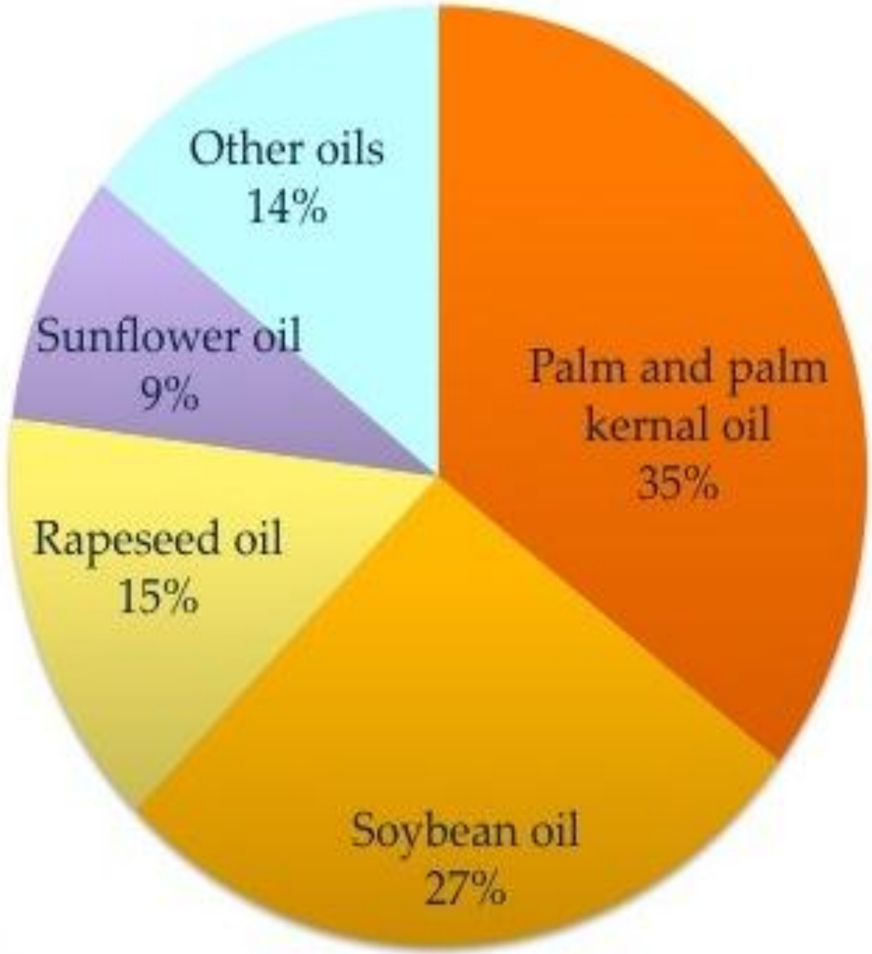
The world demand and interest in dietary oils and fats and their nutritional compositions has been steadily increasing in recent years (Bernado-Gi, *et al.*, 2002).

Oils and fats serve as a rich source of dietary energy. They contain fatty acid components which are essential nutrients (FAO, 1978) and their functional and textural characteristics contribute to the flavor and palatability of many natural and prepared foods.

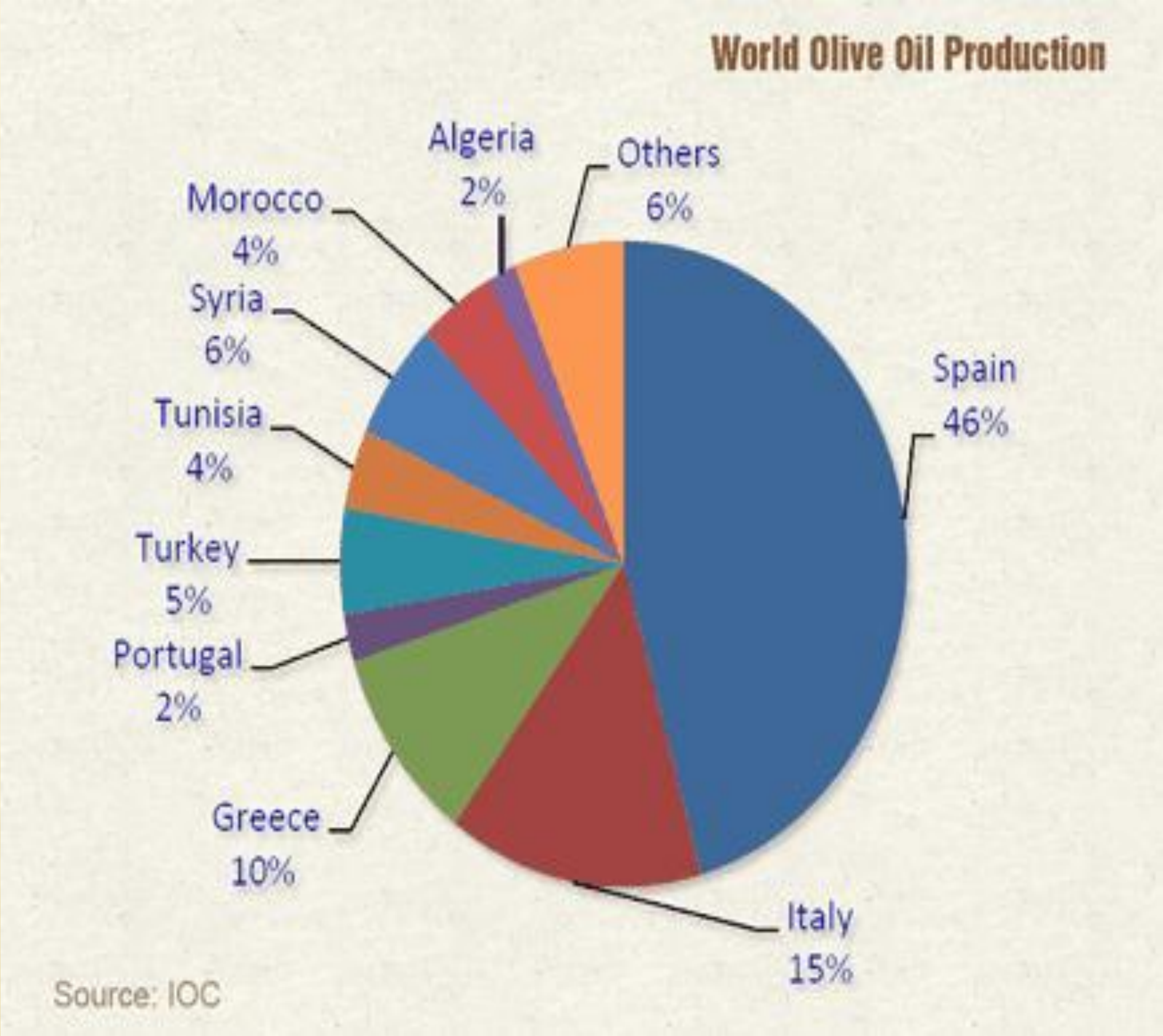
This has lead to a steady increase in the demand for functional ingredients especially those obtained by "natural" processes.

Global Vegetable Oil Production (2011)

100% = 154 million tonnes



Source: Food and Agriculture Organization of the United Nations; data arranged by TigerMine Research


World Olive Oil Production
Algeria 2%
Others 6%
Morocco 4%
Syria 6%
Tunisia 4%
Turkey 5%
Portugal 2%
Greece 10%
Spain 46%
Italy 15%
Source: IOC

COST OF ESTABLISHING & REVENUE OF 1 HECTARE OF MORINGA SEED PLANTATION

Cost of 1 moringa Seeds		10 p
Cost of Polybags for nursery		20p
Labour Cost of Nursery	50p	
Cost of Transportation & seedling transplanting	70p	
Maintenance cost per year is		2.00 gh cedis

(30 p for weeding and pruning per quarter; 20 p for irrigation, fertilization & pest control per quarter)

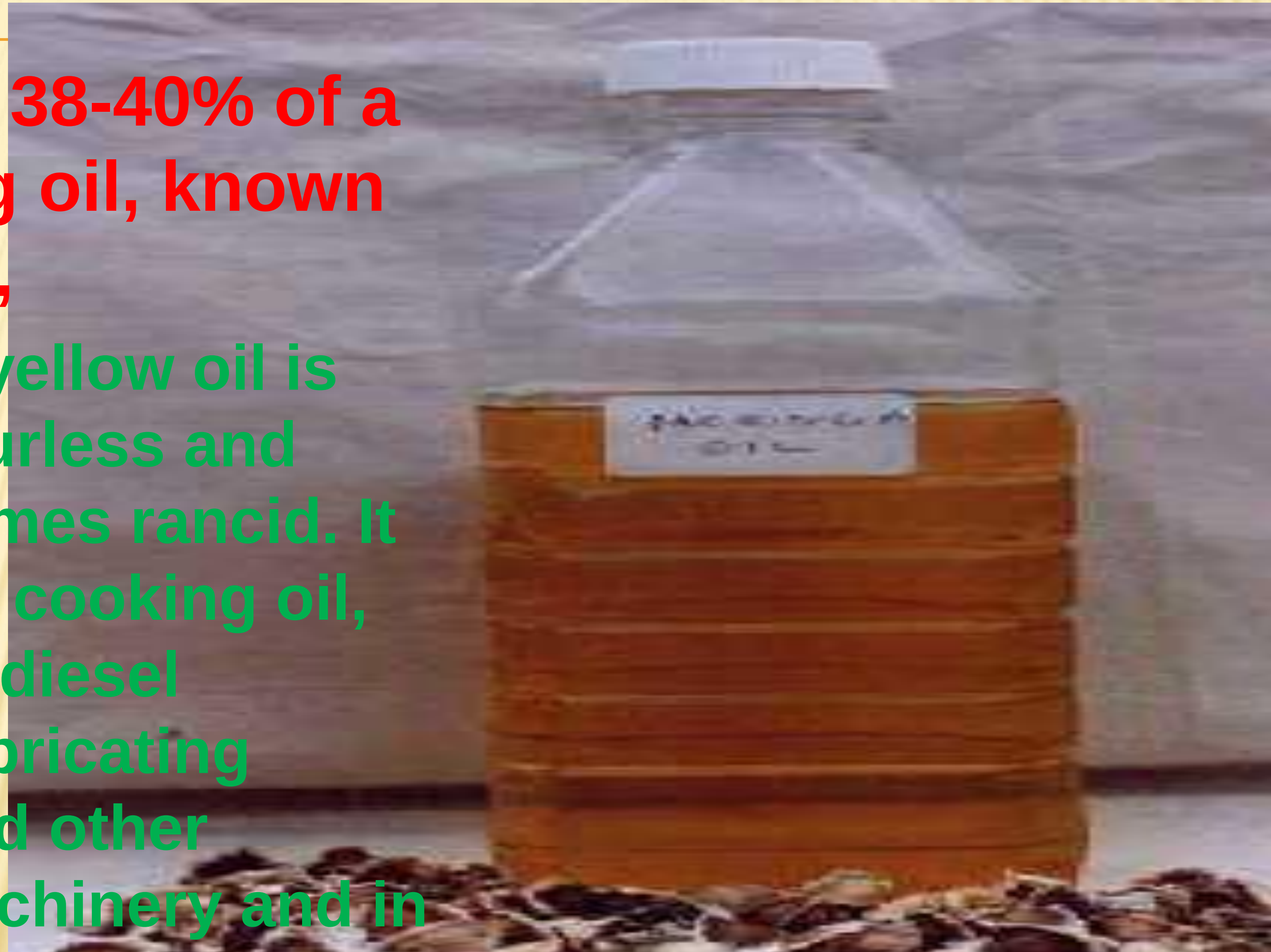
Sub-total of production cost of 1 moringa tree is	3.50 / plant	
5% contingency		0.175
Total production cost of 1 moringa tree is		3.675 gh cedis

At a spacing of 3 x 3 meters we have 1,111 plants per hectare.

Total Production cost per hectare (3.675 x 1,111)		**4,082.925 gh cedis**
Expected output is 3,000 kg per year (3yrs old)	3,000 kg	
Average current farm gate price of moringa seeds is		5 cedis /kg
Gross revenue per hectare @ farm gate		15,000 cedis
Net revenue per hectare @ farm gate		**10,918 gh cedis**
		3,119.42 US$

Seeds yield 38-40% of a non-drying oil, known as Ben Oil,

The brilliant yellow oil is sweet, odourless and never becomes rancid. It is useful as cooking oil, bio-fuel for diesel engines, lubricating watches and other delicate machinery and in the manufacture of perfumes and




Moringa seed oil contains all the fatty acids contained in olive oil, except linileic acid and was used as its acceptable substitute (Morton, 1991)

The high oleic acid (73%) is a monounsaturated fat, reduces incidence of cardiovascular disease, reduces atherosclerosis (hardening of the arteries) and incidence risk factors like heart disease, stroke and high blood pressure

It regulates the blood glucose levels and significantly lover breast cancer incidence among women

also contains 1-2% of omega-3 and omega-6 Essential Fatty Acids (EFA)

EFA favorably affect atherosclerosis, coronary heart disease, inflammatory disease, depression and even behavioral disorders(temper tantrums, learning and hyperactivity)

The oil has a high retention potential for fragrances and thus it is used as a raw material in perfune industry for extracting fragrances from different flowers etc.

The high oliec acid content of te moringa oleifera seed oil allows for longer storage and high-temperature frying.

It is more stable than Canola oil, soybean oil and palm oil; blending it with soybean and sunflower oil enhances

MORINGA SEED OIL EXTRACTION TECHNOLOGY

- Moringa seed oil is traditionally produced by boiling the seeds with water and collecting the oil from the surface of the water (Somali, *et al*., 1984) but this method of extraction has a high level of physical exertion and is time and labor intensive.
- Mechanical cold-pressing involves crushing the seed in a heat-controlled process to preserve the oil's color, flavor, nutritional quality, structure of crucial fatty acids and proteins.
- However cold-pressing has a low efficiency and a possibility of thermal degradation of the oil.

- Solvent extraction method involves the counter – current flow of solvent and oil bearing materials in the extraction vessel.
- It is usually used to recover a component from either a solid or liquid phase. The sample is contacted with a solvent that will dissolve the solutes of interest.
- Solvent extraction is of major commercial importance to the chemical and biochemical industries
- It is an efficient method of separating valuable products from complex feed stocks or reactive products.

The solvent can be a vapour, supercritical fluid, or liquid, and the sample can be a gas, liquid or solid (Bekman, 2009).

The oil yield obtained using this process is usually higher than that of mechanical method; and the residue usually contains less than 2% oil.

Usually organic solvents such as alcohols, acetone, hexane and benzene (hydrocarbons) are used .

These organic solvents, are not environmentally friendly and their incomplete removal from the oil after extraction leaves unpleasant residual effects behind.

High temperatures at the desolventization process can also cause chemical transformation of the oleoresins.

New and tougher regulatory requirements on the use of organic solvents have brought about the need to research into alternate ‘green’ oil extraction technologies.

The use of enzymes as green catalysts, have also been used to improve the efficiency of oil extraction (Rosenthal, *et al.*, 1996)

The high cost of enzymes is a major disincentive in the development of this technology.

In order to fill in the technology gap created by this situation, several authors have proposed Supercritical CO_2 extraction of oil from seeds (Salgin, 2007; Marongiu, *at al.,* 2004; Dauksas, *at al*,. 2002a; Dauksas, *et al.*, 2002b, Ill´es, *et al* 1997, . King, *et al.,* 2001, Molero, *et al.,* 2002; Papamichail, *et al.,* 2000; Ill´es, *et al.,* 2000; Szentmihalyi, *et al.,* 2002; del Valle, *et al.,* 2004).

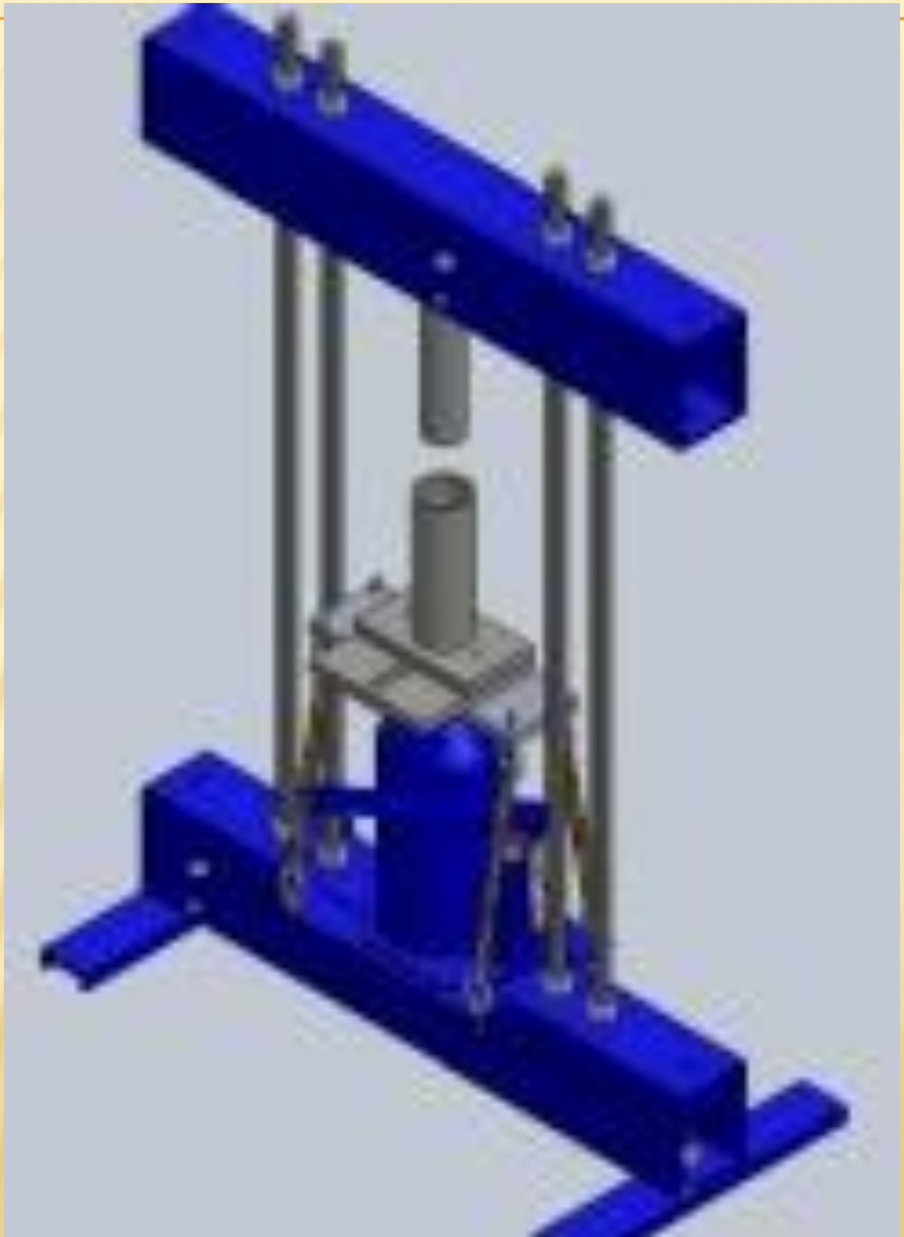
SUPERCRITICAL CO2 EXTRACTION

- Supercritical carbon dioxide is an effective extraction technique without the pitfalls of traditional methods, such as thermal degradation, low yield or solvent contamination.
- Carbon dioxide is environment friendly, safe, cheap, non-toxic, non-carcinogenic, non-flammable, and having modest critical conditions.
- It can be applied to a wide range of chemical and biochemical extraction processes.
- The selectivity of the supercritical carbon dioxide can be adjusted by varying temperature and pressure to obtain fractions consisting of desirable compounds (Babovic, *et al.*, 2010).

SCREW AND HYDRAULICS PRESSES

- Low efficiency
- Catalytic reaction between protein and oil further reduces the efficiency
- This happens when there is nickel or chromium in the steel and the temperature rises above 50 degrees Celsius
- Forming a hard plastic like substances and the oil stops to flow
- Creates the need to work with steal without chromium or nickel and further reduces the efficiency of extraction

HYDRAULIC PRESSES



HYDRAULIC PRESSES COME IS DIFFERENT TYPES AND FORMS

SCREW PRESSES COME IN DIFFERENT TYPES AND FORMS

Green world campaign
American funded project in Kenya, Africa
Contact: Marc Barasch, CEO
E: marc@greenworld.org
www.greenworld.org
www.piteba.com/eng/prices_eng.html

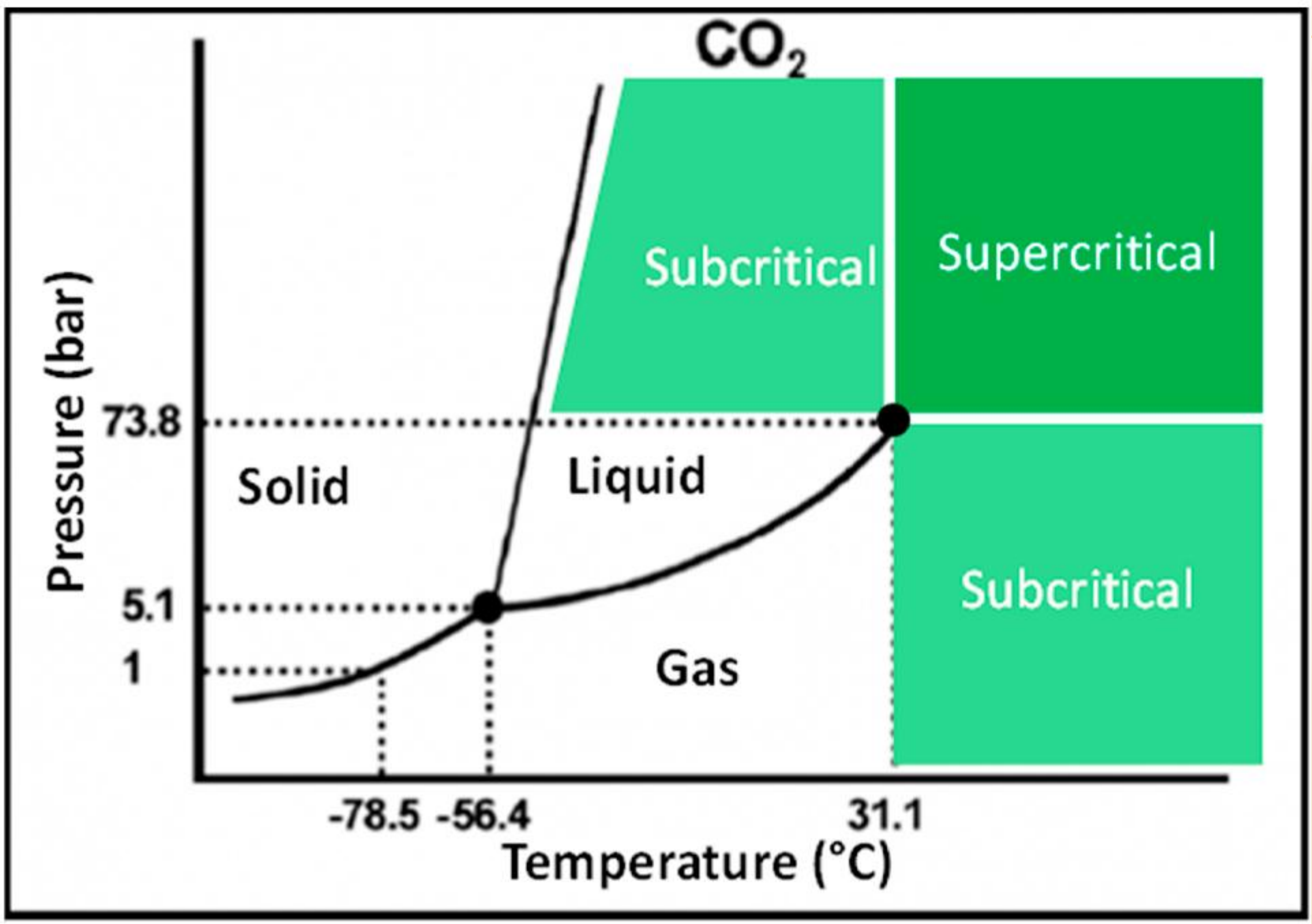
TABLE TO SCREW PRESS

SCREW PRESS

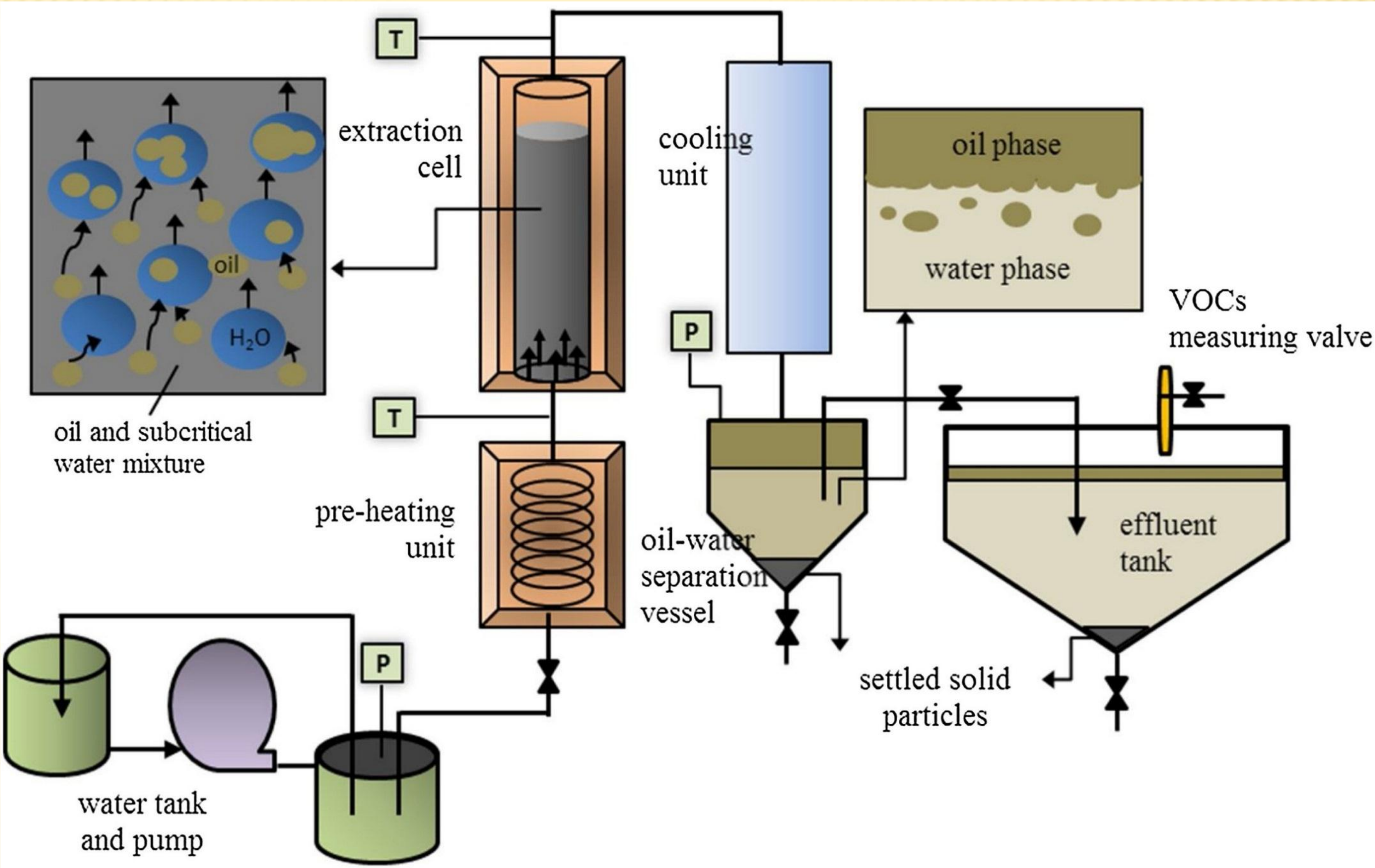
SUPERCRITICAL AND SUBCRITICAL CO2 EXTRACTION OF MORINGA OIL

- Gives you highest oil recovery rate
- Initial high cost of equipment but low maintenance(overhead) cost
- Seed cake will be detoxified and dried into high protein animal feed
- Solvent extraction contaminates the oil with solvent residue
- CO2 is easy to remove without contamination, easily available and recycling of it makes it an environmentally friendly and safer solvent for extraction

CO2 PHASE DIAGRAM



SCHEMATIC OUTLINE



LABORATORY SCALE SUPERCRITICAL EXTRACTION UNIT

SIDE VIEW OF LAB SCALE SUPERCRITICAL EXTRACTION UNIT

Pilot Scale Supercritical CO2 set up

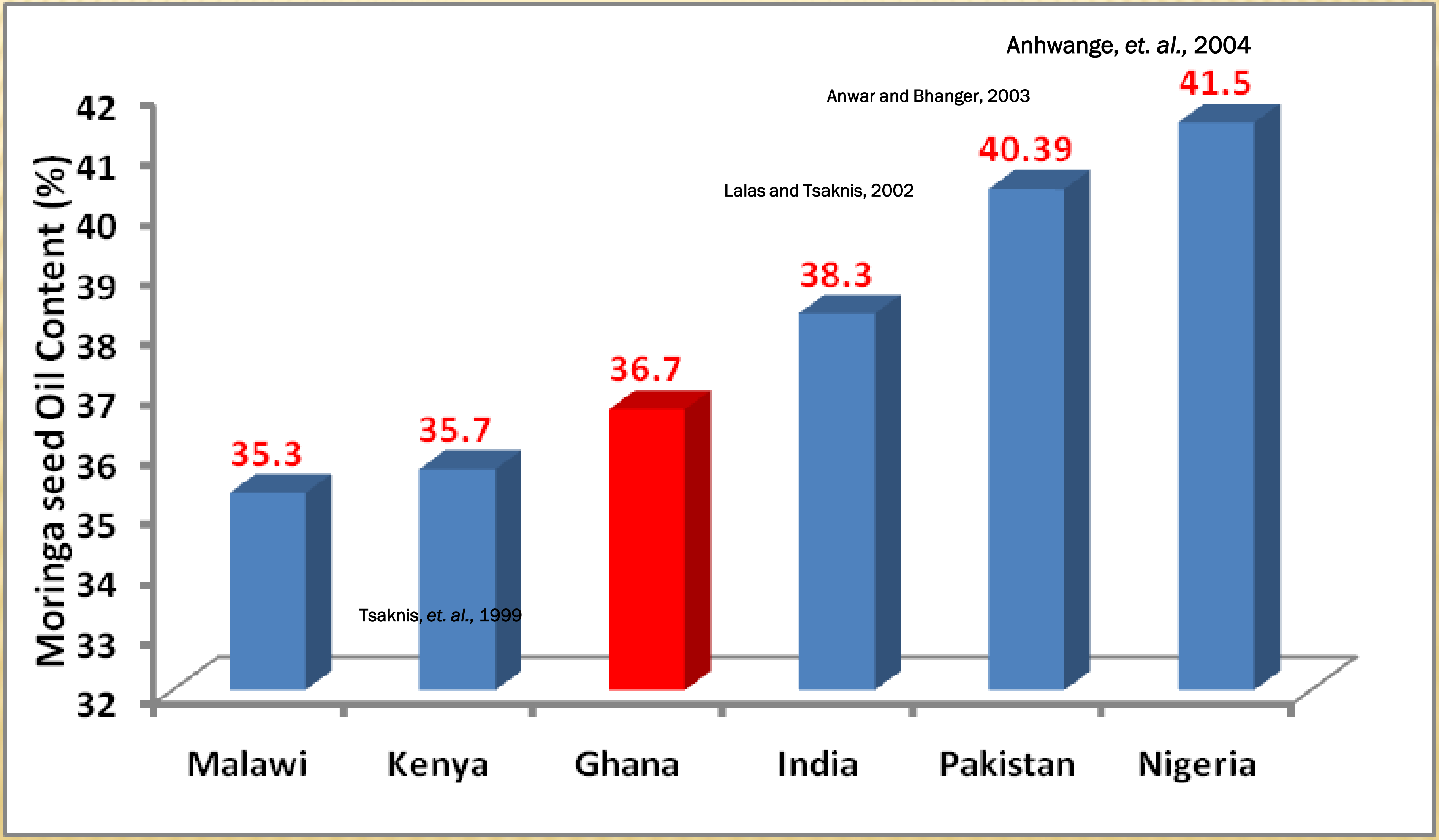
SUPER AND SUBCRITICAL EXTRACTION UNIT

OIL QUALITY AND YIELD DEPENDS ON THE EXTRACTION TECHNOLOGY

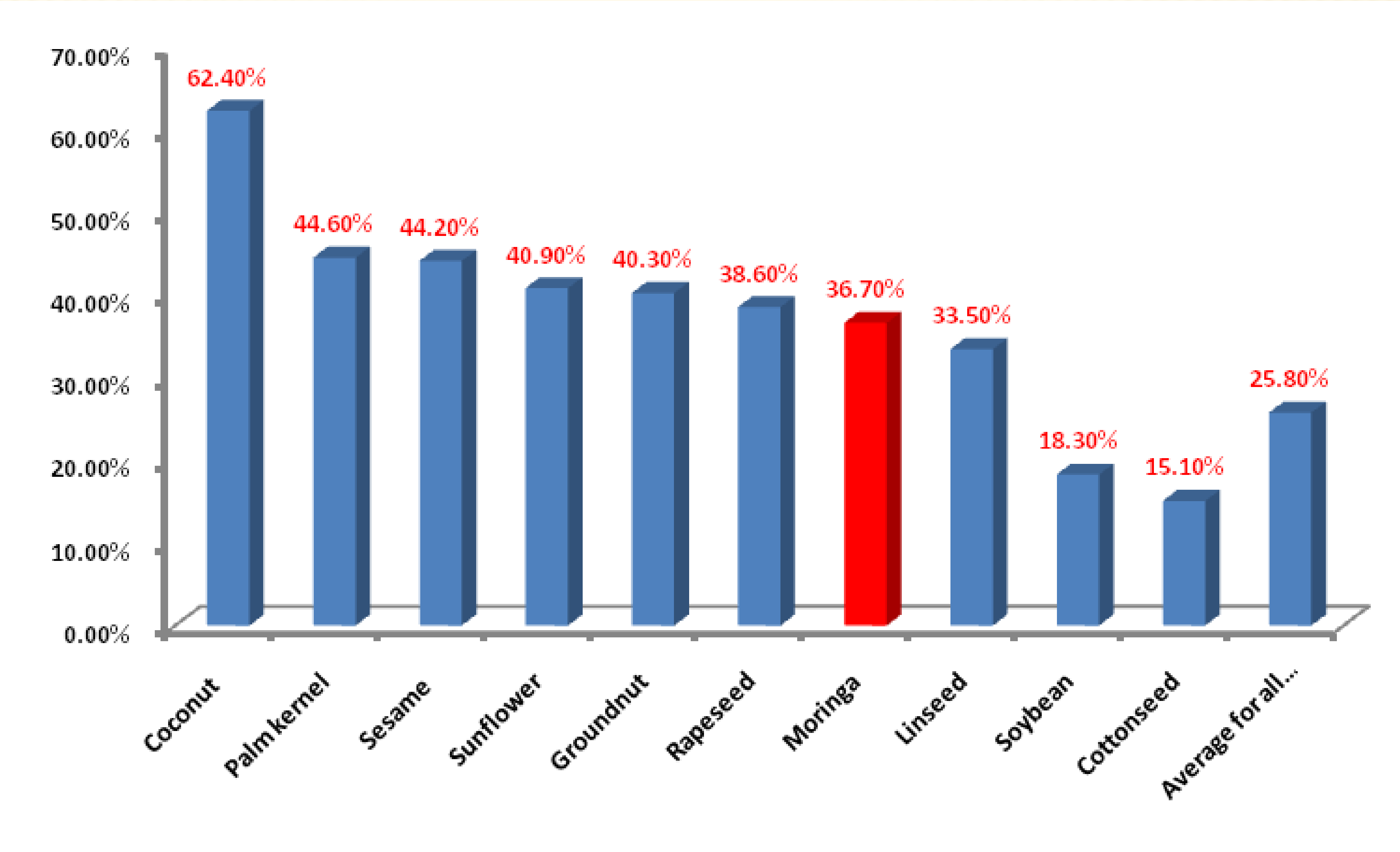

Cold Pressed oil


Supercritical CO2 extracted oil

Comparing Oil Content by different authors

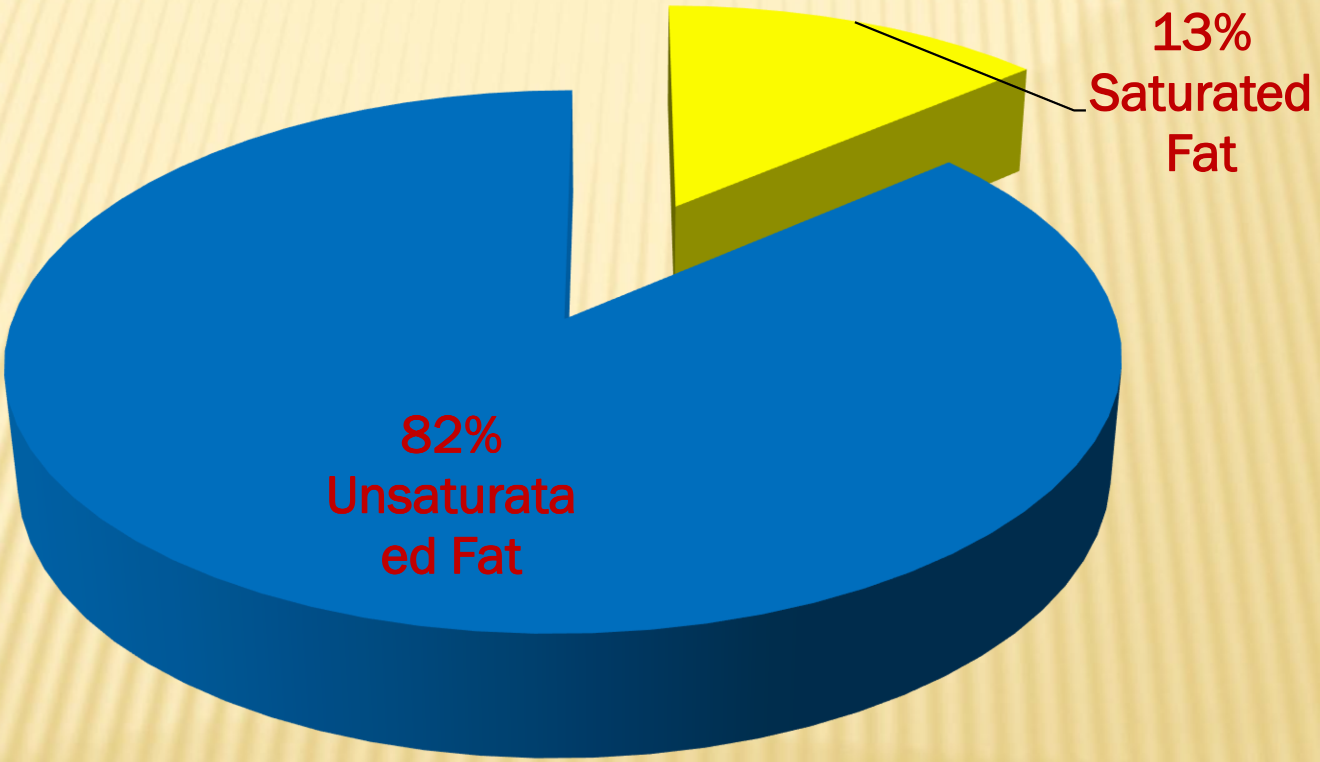


Comparing Major Oil seed



MORINGA SEED OIL CONTENT & COMPOSITION

Contains 32 to 40 % oil



Sensory Evaluation of *Moringa oleifera* Seed Oil Samples

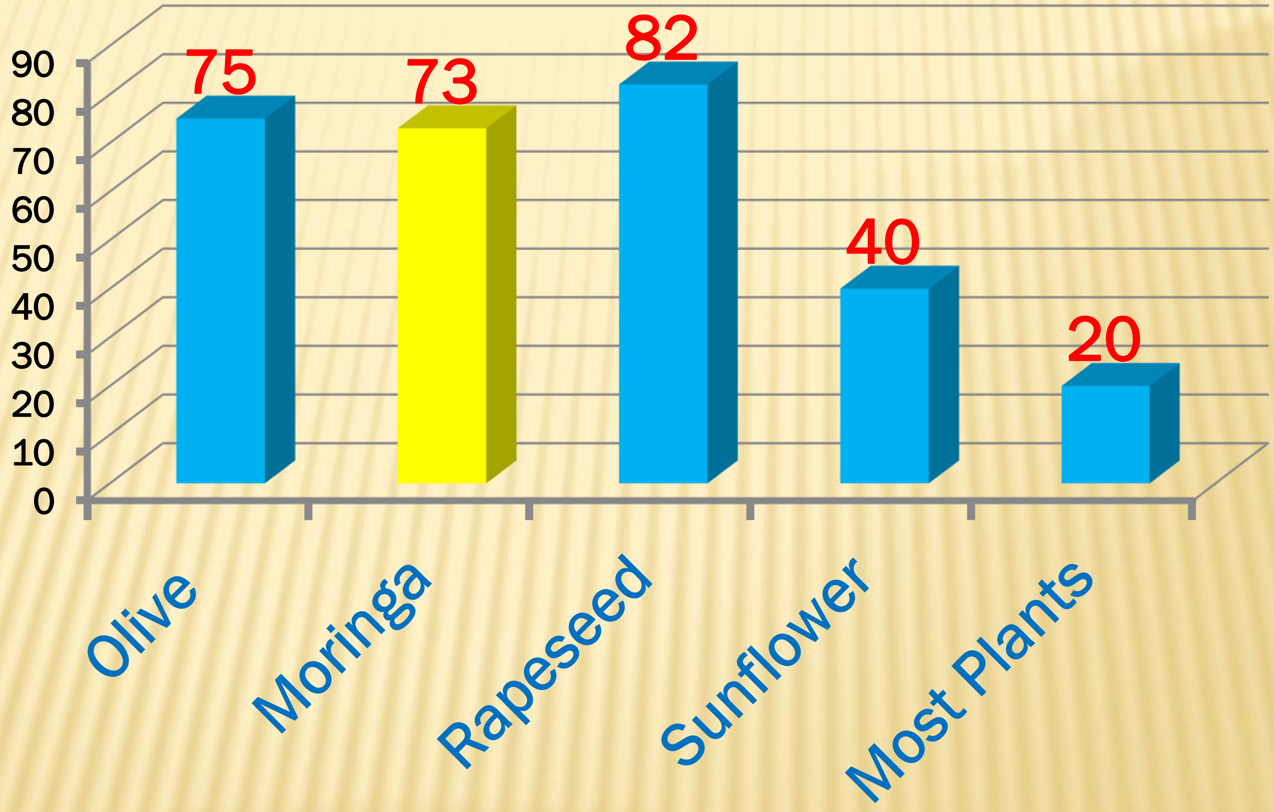
Sensory index	Colour	Odour	Taste
SCF CO_2	**Bright Yellow**	**Faint**	**Normal Taste**
Cold Press	**Yellowish Brown**	**Faint**	**Normal Taste**

Physico-chemical properties of *Moringa oleifera* seed oil

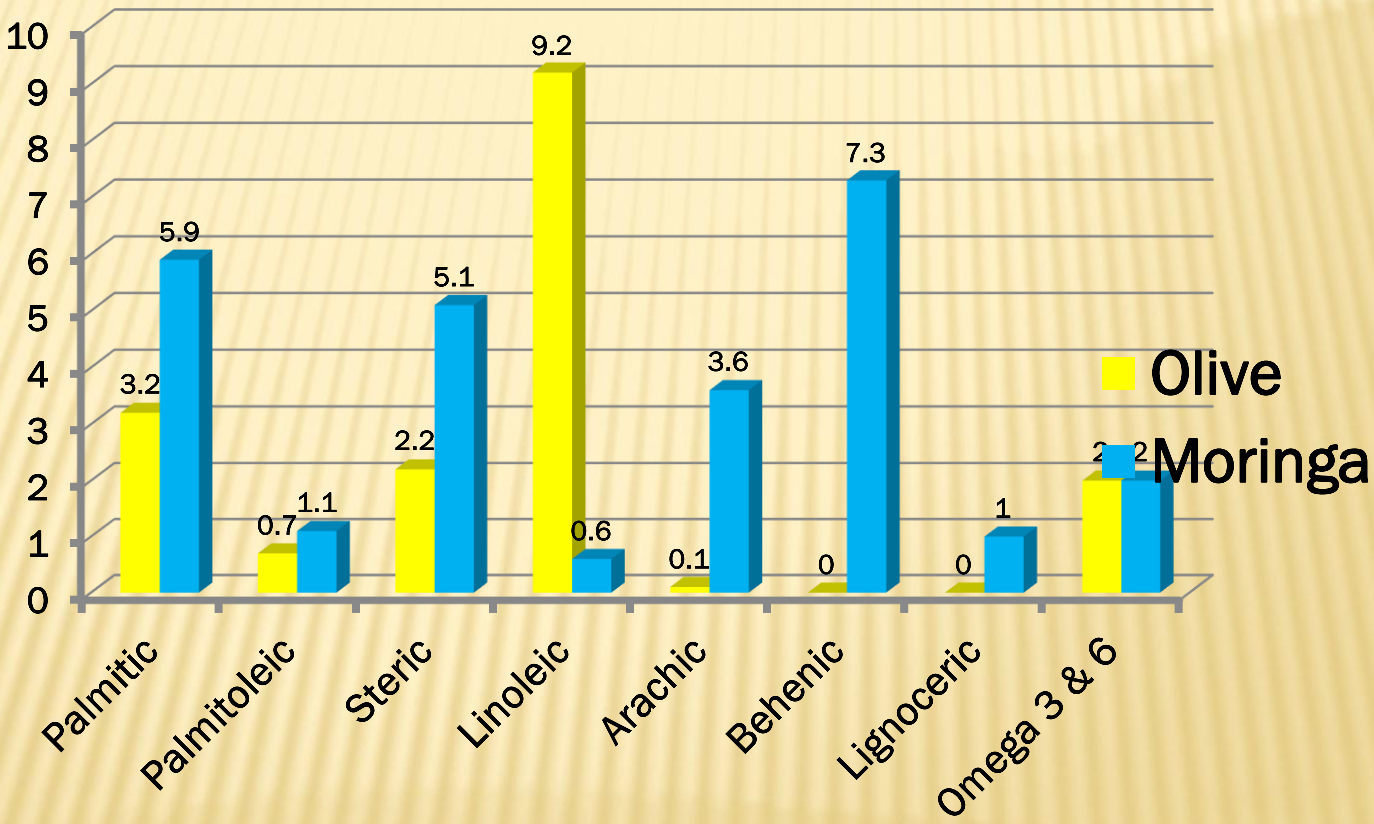
Chemical index	Oil sample					
	L1	L2	L3	L4	L5	Virgin olive oil[a]
Saponification Value (mg KOH/g)	143.33	155.66	147.31	167.52	158.23	188
Peroxide value (Meq/Kg)	0.07	0.360	--	0.028	0.043	0.76
Acid Value (as oleic acid in mg/g)	1.33	2.38	4.16	1.02	5.26	0.98
Iodine value (g of I/ of oil)	62.12	63.37	64.175	67.31	64.48	80.01
Density (mg/mL) at 24 °C	0.898	0.896	0.910	0.894	0.898	0.915
Moisture (%)	3.21	3.41	3.4	3.20	3.31	-

[a] Data from Lalas and Tsaknis, 2002

OLEIC ACID CONTENT OF OILS IN %



OTHER MONOUNSATURATED FATTY ACIDS IDENTIFIED INCLUDE



	Moringa oleifera	
Fatty Acid	**Solvent Extraction**	**Super Critical CO_2**
Lauric (C12:1)	**-**	**0.01**
Myristic (C14:0)	**0.09**	**0.11**
Palmitic (C16:0)	**8.19**	**8.93**
Palmitoleic (C16:1)	**1.87**	**1.93**
Stearic (C18:0)	**6.40**	**6.00**
Oleic (C18:1)	**62.25**	**66.58**
Linoleic (C18:2)	**1.00**	**0.90**
γ-Linolenic (C18:3)	**0.22**	**0.20**
Arachidic (C20:0)	**4.41**	**3.43**
Paullinic (C20:1)	**3.84**	**0.10**
Behenic (C22:0)	**9.29**	**6.29**
Erucic (C22:1)	**0.28**	**0.16**
Lignoceric (C24:0)	**0.94**	**0.48**

GC-MS analysis results of major fatty acids profile of *Moringa oleifera* oil

Fatty acids profile of *Moringa oleifera* oil with profile of palm, rapeseed (Canola), soyabean and sunflower oils shown for comparison purposes

Fatty Acid	*MO* (Supercritical CO2)	MO[e]	MC[d]	Virgin Olive Oil[f]		Corn[g]	Rape seed[a]	Soya bean[a]	Sun flower[a]
C12:1	0.01	-	-	-	-	-	-	-	-
C14:0	0.11	0.13	-	<0.01	1.1	0.13	-	-	-
C16:0	8.93	6.5	11.04	11.2	44.1	5.95	3.6	11	6.4
C16:1	1.93								
C18:0	6.00	6.0	2.38	2,8	4.4	5.78	1.5	4	4.5
C18:1	66.58	72.2	68.00	74.53	39.0	66.96	61.6	53.4	63.8
C18:2	0.90	1.0	3.58	8.82	10.6	0.59	21.7	23.4	24.9
C18:3	0.20	-[b]	1.83	1.12	0.3	0.17	-	7.8	-[b]
C20:0	3.43	4.0	3.44	<0.01	0.2	3.77	1.4	-	-
C20:	0.10	2.0	1.73	<0.01	-	2.12	-	-	-
C22:0	6.29	7.1	7.09	-	-	6.05	-	-	-
C22:1	0.16	0.12	-	-	-	-	0.2	-	-
C24.0	0.48	-	-	-	-	-	-	-	-
S:M:P $n_6:n_3$	-	1	-		Trace			Trace	Trace

MO= *Moringa oleifera* MC= *Moringa conconicense* [c] Eicosenoic acid

[a] Data from Gunstone and Harwod, 2007. The values constitute averages of numerous samples

[b] This may indicate traces (<1%) or absence of these fatty acids

[d] Data from Maleeha, *et. al.*, 2007

[e] Data from Umer, *et al.*, 2008

[f] Data from Lalas and Tsaknis, 2002

[g] Data from Zhai and Zhang, 2014

PHYSICAL AND CHEMICAL CHARACTERISTICS

(Tsaknis et al., 1999)

Determination	Cold Press	*n*-Hexane	Chloroform: Methanol	*P1*	Virgin olive oil	*P2*
Oil content	25.1	38.3	41.4	0.05	NS	NS
(g oil/100 g seed)	(3.01)	(3.14)	(2.92)			
Density at 241C	0.899	0.909	0.911	0.05	0.915	0.001
(mg/mL)	(0.006)	(0.004)	(0.006)		(0.007)	
Refractive index	1.46				1.462	0.05
(n_D 40°C)	(0.004)	(0.002)	(0.005)		(0.005)	
Colour	1.90/30.00	0.80/35.00	2.00/35.00	0.05	0/47.00	0.05
(red/yellow)	(0.10)/(2.40)	(0.20)/(3.14)	(0.30)/(3.90)		(0.00)/(7/91)	
Smoke point	203	200	206	0.001	190	0.05
(°C)	(2.5)	(2.0)	(2.0)		(1.9)	

1Note: Values are means of triplicate determinations and standard deviation is given in parenthesis.
P1: Level of significant difference between methods of extraction. P2: Level of significant difference PKM 1 versus virgin olive oil.
2Non degummed oil. 3Degummed oil. NS: non significant.

PHYSICAL AND CHEMICAL CHARACTERISTICS *CONT…*

(Tsaknis et al., 1999)

Determination	Cold Press	*n*-Hexane	Chloroform: Methanol	*P1*	Virgin olive oil	*P2*
Viscosity (mPa s)	80 (0.92)	45.05 (0.13)	56.1 (0.12)	0.05	74.01 (0.17)	0.05
Free fatty acids[2] (oleic acid %)	1.94 (0.21)	1.12 (0.2)	1.39 (1.19)	0.01	0.98 (0.11)	0.05
Saponification value3 (mgKOH/g)	199.32 (3.99)	188.35 (4.02)	186.32 (3.66)	0.05	188 (4.99)	0.05
Iodine value[3] (g I/100 g)	65.73 (0.49)	65.58 (0.48)	65.46 (0.47)	NS	80.01 (0.71)	0.05

1Note: Values are means of triplicate determinations and standard deviation is given in parenthesis.
P1: Level of significant difference between methods of extraction. P2: Level of significant difference PKM 1 versus virgin olive oil.
2Non degummed oil. 3Degummed oil. NS: non significant.

Fatty acid composition (%)	Value 1	Value 2
Lauric	Trace	(ND)
Myristic	0.08	(0.05)
Pentadecanoic	Trace	(ND)
Palmitic	5.45	(4.75)
Palmitoleic	1.48	(1.22)
Margaric	0.08	-
Margaroleic	0.05	-
Stearic	5.42	(5.66)
Oleic (C18-1)	72.9	(71.0)

(Tsaknis et al., 1999)

1: Analysis: Thionville Laboratories, Inc. New Orleans, USA (March 1994)
2: Values in parantheses (Foidl, *et al.,* 2001)

Fatty acid composition (%)	Value 1	Value 2
Linoleic	0.76	(0.46)
Linolenic	0.14	(0.09)
Arachidic	3.39	(4.01)
Gadoleic	2.2	(2.24)
Eicosadieroic	-	(ND)
Behenic	6.88	(9.03)
Erucic	0.14	(0.13)
Lignoceric	0.92	(1.12)
Nurvonic	Trace	-
Cerotic	-	(ND)
Other Fatty Acids	0.10	(0.2)

(Tsaknis et al., 1999)

1: Analysis: Thionville Laboratories, Inc. New Orleans, USA (March 1994)
2: Values in parantheses (Foidl, *et al.,* 2001)

FATTY ACIDS OF DEGUMMED MORINGA OIL

Determination	Cold Press	*n*-Hexane	Chloroform: Methanol	*P1*	Virgin olive oil	*P2*
C8:0	0.04 (0.01)	0.03 (0.01)	0.3 (0.01)	NS	Not detected	0.05
C14:0	0.13 (0.08)	0.13 (0.08)	0.13 (0.06)	NS	<0.01	0.05
C16:0	6.34 (0.41)	6.46 (0.32)	6.36 (0.25)	NS	11.2 (0.66)	
C16:1 *cis n-9*	0.1 (0.06)	0.09 (0.04)	0.09 (0.04)	NS	1.22 (0.71)	0.05
C16:1 *cis*n-7	1.28 (0.87)	1.36 (0.84)	1.4 (0.82)	NS	Not detected	0.05

(Tsaknis et al., 1999)

FATTY ACIDS OF DEGUMMED MORINGA OIL CONT.....

Determination	Cold Press	*n*-Hexane	Chloroform: Methanol	*P1*	Virgin olive oil	*P2*
C17:0	0.08 (0.02)	0.08 (0.02)	0.08 (0.02)	NS	<0.01	0.001
C18::0	5.7 (0.21)	5.88 (0.23)	5.74 (0.24)	NS	2.8 (0.12)	0.05
C18:1	71.6 (0.73)	71.21 (0.69)	71.22 (0.70)	NS	74.53 (0.82)	0.05
C18:2	0.77 (0.38)	0.85 (0.32)	0.66 (0.33)	NS	8.82 (0.79)	0.05

(Tsaknis et al., 1999)

FATTY ACIDS OF DEGUMMED MORINGA OIL *CONT*.......

Determination	Cold Press	*n*-Hexane	Chloroform: Methanol	*P1*	Virgin olive oil	*P2*
C18:3	0.2 (0.03)	0.18 (0.05)	0.17 (0.05)	NS	1.12 (0.04)	0.05
C20:0	3.52 (0.29)	3.62 (0.33)	3.6 (0.44)	NS	<0.01	0.05
C20:1	2.24 (0.26)	2.22 (0.26)	2.25 (0.20)	NS	<0.001	0.05
C22:1 *cis*	6.21 (0.49)	6.41 (0.46)	6.28 (0.47)	NS	<0.01	0.05
C:22:1 *cis*	0.12 (0.07)	0.12 (0.07)	0.12 (0.08)	NS	Not detected	0.05
C26:0	1.21 (0.16)	1.18 (0.20)	1.23 (0.21)	NS	Not detected	0.05

(Tsaknis et al., 1999)

STEROL COMPOSITION OF DEGUMMED MORINGA OIL

Determination	Cold Press	*n*-Hexane	Chloroform: Methanol	*P*	Virgin olive oil	*P*
Total sterols in oil (%w/w)	0.52 (0.03)	0.56 (0.04)	0.48 (0.04)	NS	0.57 (0.04)	NS
Cholesterol	0.18 (0.04)	0.1 (0.02)	0.12 (0.03)	NS	0.15 (0.02)	NS
Brassicasterol	0.06 (0.02)	0.05 (0.01)	0.05 (0.01)	NS	<0.1	0.05
24, Methylene cholesterol	0.07 (0.01)	0.08 (0.01)	0.09 (0.01)	NS	Not detected	0.05
Campesterol	15.81 (1.1)	15.29 (1.09)	14.6 (1.01)	NS	3.2 (0.95)	0.05

(Tsaknis et al., 1999)

STEROL COMPOSITION OF DEGUMMED MORINGA OIL *CONT…..*

Determination	Cold Press	*n*-Hexane	Chloroform: Methanol	*P*	Virgin olive oil	*P*
Campestanol	0.36 (0.05)	0.33 (0.05)	0.33 (0.03)	NS	0.29 (0.03)	NS
Stigmasterol	23.1 (1.63)	23.06 (1.13)	22.5 (1.19)	NS	0.6 (0.09)	0.05
Ergostadienol	0.3 (0.04)	0.35 (0.04)	0.36 (0.04)	NS	Not detected	0.05
Clerosterol	2.08 (0.12)	1.22 (0.09)	1,80 (0.09)	NS	0.54 (0.26)	0.05
β-Sitosterol	45.58 (3.66)	43.65 (2.79)	44.05 (3.02)	NS	64.3 (4.35)	0.05

(Tsaknis et al., 1999)

STEROL COMPOSITION OF DEGUMMED MORINGA OIL *CONT……*

Determination	Cold Press	*n*-Hexane	Chloroform: Methanol	*P*	Virgin olive oil	*P*
Stigmastanol	0.76 (0.10)	0.64 (0.17)	0.74 (0.11)	NS	0.4 (0.08)	0.05
Δ5-Avenasterol	8.46 (0.92)	11.61 (1.14)	10.43 (1.01)	NS	16.77 (1.23)	0.05
Δ7, 14 Stigmastadienol	0.52 (0.22)	0.39 (0.10)	0.4 (0.09)	NS	Not detected	0.05
28, Isoavenasterol	0.27 (0.12)	0.25 (0.11)	0.4 (0.09)	NS	Not detected	0.05
Δ7, 14 Stigmastanol	0.35 (0.14)	0.85 (0.29)	0.51 (0.19)	NS	<0.1	0.05
Δ7, Avenastenol	0.53 (0.07)	Not detected	1.15 (0.19)	NS	0.29 (0.06)	0.05

(Tsaknis et al., 1999)

TOCOPHEROL COMPOSITION OG NON DEGUMMED MORINGA OIL

Determination	Cold Press	*n*-Hexane	Chloroform: Methanol	*P1*	Virgin olive oil	*P2*
α-Tocopherol	5.06 (0.67	15.38 (0.68)	2.42 (0.37)	0.05	88.5 (6.30)	0.05
γ-Tocopherol	25.4 (1.16)	4.47 (0.87)	5.52 (0.69)	0.05	9.9 (0.65)	0.05
δ-Tocopherol	3.55 (0.45)	15.51 (0.99)	12.67 (0.55)	0.05	1.6 (0.86)	0.05

(Tsaknis et al., 1999)

“Moringa shows great promise as a tool to help overcome some of the most severe problems in the developing world—malnutrition, deforestation, impure water and poverty. The tree does best in the dry regions where these problems are worst.”

- Andrew Young, former Atlanta Mayor and United Nations Ambassador

“Although few people have ever heard of it today, Moringa could soon become one of the world’s most valuable plants, at least in humanitarian terms.”

- Noel Vietmeyer, US National Academy of Sciences, Washington D.C.


Dr. Nikolaus Foidl, Austria.
The father of moringa
Dr. Vanisha of India
Dr. David Makin
Dr. Newton Amaglo
Certificate of Appreciation
Dr. David Makin
Certificate of Appreciation
Dr. Nikolaus Foidl