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Happy farming: a pathway to sustainable oils through evaluating the impact of integrated organic agriculture on the quality and sustainability of flaxseed and poppy seed oils.

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ABSTRACT

The research study was conducted to figure out the impact of farming; whether organic or conventional; on the quality of flaxseed and poppy seed oils. Lab experiments have revealed that oils from organic farming have better quality, stability and lower acidity than conventional agriculture, but also better sensory and organoleptic analysis. Organic flaxseed had a stable texture that reflected it's richness in PUFAs (polyunsaturated fatty acids) more than conventionally farmed flaxseeds. Poppy seed oil from organic sources was superior in it's appearance to that from a conventional source which was cloudy and unstable. Moreover, both oils from organic sources demonstrated promising antibacterial and antifungal actions with higher oxidative stability for organic seeds than conventional seeds after being exposed to harsh environmental conditions of gradual heating, moisture and air. These lab experiments are accompanied by an observational study from individual expert opinions on the superiority of integrated organic farming that gives profoundly high yields at low costs, giving bioremediation to what chemical farming has destroyed in the past 30 to 40 years ago. With more emphasis on Soil Health, Climate Change Mitigation and achieving resilience in terms of food security and achieving sustainable diet within global food systems that align with SDGs1,2,3,12 and 13; (No Poverty, Zero Hunger, Good Health, Responsible Consumption & production and Climate Action).

Keywords: Organic Farming, Happy Farming, Fat Extraction, Soil Health, Sustainable Diet

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INTRODUCTION

Soil, as the most precious asset on earth, must be restored and treated in a delicate manner, without resorting to harmful pesticides, insecticides or fertilizers.

Chemicals not only cause definitive harm to human health, but they also deteriorate land's fertility and productivity. Chemicals pollute run-offs, thus it causes eutrophication, where top water is blocked by microorganisms, consequently, dead areas of water are created with no fish

due to migration or dead sea and marine creatures. **(Solomon, 2023)**

This research study strongly recommends shifting towards regenerative agriculture and organic farming for both human health and the environment, with circular-economy approaches and more evidence-based awareness to multiple stakeholders such as key farmers, landlords, the private sector and researchers to maintain food security for the unstoppable growing population that will provisionally reach 9.8 billion people by 2050 with estimations of 2 billion people with mild to severe hunger and food insecurity. **(Roy a b et al., 2024)**

The design of the study was first conducted as an evidence-based qualitative observational analysis of professional expert panel opinion on the profound success of organic farming and the undeniably obvious long-term conundrums of conventional farming. Secondly, quantitative experimental lab Analysis of the quality of oils extracted from organic sources and conventional sources. Acidity, organoleptic, fuming point, oxidative Stability, antibacterial and antifungal tests were conducted on both organic and traditional farming seeds.

According to the qualitative observational analysis from the professional expert panel opinion, as well as quantitative experimental results conducted in the lab setting, both favored organic integrated farming rather than conventional methods of farming.

MATERIALS AND METHODS

As per expert panel opinions:

A panel of experts were interviewed on the topics of integrated organic farming, regenerative agriculture and sustainable diet systems. The following themes and sub-themes were extracted after analyzing the experts' scripts.

Theme 1: "Integrated Organic Agricultural System

This agricultural method of farming relies majorly upon circular-economy approaches to achieve food security and zero hunger SDG2.

The key point is to achieve a sustainable agro-food system that uses zero chemical pesticides, insecticides or fertilizers, at the same time achieving maximum yields with minimal costs, so at the end of the day, food is cultivated and produced sustainably with maximum health benefits and minimal environmental impacts.

Hydroponics is frequently used in large-scale commercial farms, especially for growing lettuce and tomatoes. It's thought to be one of the most sustainable farming systems due to its emphasis on water conservation, lack of harmful chemicals and lack of soil damage

Theme 2: Growing population

Provisionally, by 2050 there will be 9.8 billion people globally, 2 billion people will suffer from food insecurity issues.

"In Egypt, there is a growth of 2.5 million people annually, those people will need more food in the future".

In Europe, land fertility has declined to more than 60%, food resources are fixed, productivity decreases and populations are growing.

" Egypt has a massive desert land; by different vertical farming methods this land can achieve a miracle".

Theme 3: Soil Health

Soil health is our health; the key to healthy soil is no chemicals (organic farming), Soil Health can be maintained by 3 agricultural systems.

1. Organic Agriculture
2. Regenerative Agriculture
3. Smart Agricultural System

This can be ideally achieved by climate mitigation and adaptation to achieve resilience, consequently generating sustainable diet systems.

The basic goals of sustainable agriculture are environmental health, economic profitability, and social and economic equity (sometimes referred to as the “three legs” of the sustainability stool).

Theme 4: Awareness for future generations

SDGs are designed and created with a major focus on future generations.

New generations of researchers and farmers must be aware of how to enhance the fertility of lands and maximizing yields at lower cost and in the same land size.

" In Egypt, we do 300 field training and scholarships every year in 26 governorates.

There should be 2 languages: one for the farmers, which is simple and without fancy jargons and one for researchers with data analysis and evidence-based scientific research.

Globally, farmers have one aim which is increasing the yield with the lowest cost, so farmers need more evidence and witnesses to apply clean farming methods.

Green deal: this is a critical solution that farmers and landowners need to collaborate, so short statements will be a real-field experiments.

To prevent GMOs from being introduced into organic production, producers do not use genetically modified seeds or other materials when planting crops. They also work with their certifiers to implement preventative practices that effectively buffer their farms from GMO contamination.

Theme 5: "Soil is the most precious asset in our lives" Soil is divided into 3 categories:

1. Conducive soil: it is susceptible to many kinds of soil-borne diseases, no yield is guaranteed in this kind of land or any economic benefit.
2. Conventional soil: which requires significantly large amounts of chemicals from fertilizers, insecticides and pesticides, so that land can generate any yield or economic benefit. Unfortunately in this particular type of land, farmers pay a lot of money to get high yields, moreover yields are contaminated with chemicals that leads to high prevalence of non-communicable diseases, especially in multiple kinds of cancers.
3. Suppressive soil: the challenge is to convert conducive soil into suppressive soil, which is healthy and resilient, but also mitigates climate shocks and suppresses soil and water diseases. " This is one key aspect of circular-economy as functional organic matter is used to generate this kind of suppressive soil".

This trend started and was initiated decades ago. Scientists have been working on how to convert conducive soil into suppressive soil, that suppresses all kinds of bacterial, fungal and nematode diseases without any reliance on pesticides, which can be a key to achieving SDG2 Zero Hunger and SDG3 Climate Action.

Theme 6: Stakeholder collaboration in the food system

Multiple stakeholders in the food system have to effectively collaborate with optimum alignment, sharing the same agenda and the same pledge with implementation plans to maximize yields and control borne diseases, so higher yields will be obtained but also safer food.

"Farmers need a real catalyst to change farmer's mentality towards regenerative agriculture"

Key farmers need to gather with focus groups and well-designed road maps, teaching them the most fundamentally effective methods to valorize dead land into productive land with bioremediation with micro flora and Fiona.

The core of bioremediation is through using biological fertilizers, bio-stimulants, bio pesticides, organic matter and organic compost. This will definitely assist in achieving the target of doubling the yield at the cheapest possible price.

.In the future, as climate change poses increasing threats to conventional agriculture, organic farming will become an essential safeguard for food security.

Farmers learn by evidence; they need to do this by their own hands and touch tangible success. That's how they can go forward and apply it on a future basis.

Theme 7: "Soil nature and human nature are the same"

Both soil and human being are the same; they possess microbiomes, they need to eat healthy in order to feed these micro biota.

" Any nation which destroys its soil, it destroys its civilization accordingly" simply because, when soil gets sick, automatically people will get sick.

"Green revolution in the agro-food system"

Genetic engineering and Biotechnology Research Institute

An ongoing revolution in the agro-food system where teams of global researchers collaborate, not only to provide safe food, but also medicinal food and immunity boosting food products.

"Researchers at GEBRI are working tirelessly to provide edible packaging instead of chemical coating as well as extending the shelf life for food products to withstand after-harvest diseases and to slow down ageing". "Subtheme "

How to design a regenerative land

The simple secret to regenerative agriculture is to regenerate the land by adding organic matter and organic compost from agricultural waste and beneficial microbes.

That's mainly to rebuild what have been destroyed by conventional farming in the past 40 years.

Theme 8: success stories in integrated organic farming

1. Medicinal honey: honeybees absorb nectar and are fed on medicinal plants and no traditional sucrose. The net product is honey with high health benefits and immune boosting, but also high organoleptic features.
2. Enhancing protein content in certain strains of mushrooms. The remaining byproduct is up cycled by circular-economy into a very nutritious feed for cows and buffaloes.
3. Increasing the fertility of summer crops and forage crops to elevate milk and meat content in animals.

"The target was to save 40% of water and double the yield for green feed for cows and buffalo the cheapest way"

After 3 years of research and development, each fed an achieved 45 tons compared to the traditional yield of 20-22 tons. Furthermore, protein concentration increased to 16-22% Compared to the normal of 6-8%.

"It's a matter of awareness and to convince farmers to move from conventional farming into regenerative organic farming"

As per Experimental Analysis:

Fat contents were extracted by 2 different methods from flaxseeds and poppy seeds from organic and conventional sources.

First fat extraction method was by solvent extraction

1st sample: Conventional Farming Poppy Seeds

The sample of ground seeds was 85 grams, solvent of 900ml of petroleum ether was added to the sample with hours of continuous magnetic shaking

Observation: 2 separate layers were observed after 2 hours of shaking, then 3 layers were separated and finally 4 layers were obtained with different densities, colors and textures.

After adequate shaking time, the sample went through a filtration process and finally, the solvent was evaporated on the rotary evaporator to obtain the crude oil sample.

Net sample obtained was: 19.13 grams of pure oils.

Color: Dark brown and cloudy. Solidified after 12 hours.

Density: High

Fuming point: 73°c

Note: The experiment was conducted on a Soxhlet apparatus again to verify the outcome measurement. Acidity Value experiment was conducted on the oil sample after 24 hours of extraction to assure that there are no remaining solvents with careful storing and handling. **(Ghulam Hussain, 2023)**

2nd Sample: Organic Poppy seeds

Lab Analysis: Fat contents was extracted by 2 different methods from flaxseeds and poppy seeds from organic and conventional sources.

First fat extraction method was done by solvent extraction

The sample of ground seeds was 91.2 grams, a solvent of 900ml of petroleum ether was added to the sample with hours of continuous magnetic shaking.

Observation: 2 separate layers were observed after 2 hours of shaking, then 3 layers were separated and finally 4 layers were obtained with different densities, colors and textures.

After adequate shaking time, the sample went through filtration process and finally solvent was evaporated on the rotary evaporator to obtain the crude oil sample. Net sample was: 7.92 grams of pure oils. Texture remained oily at room temperature

Color: Light brown and clear. Without oxidation.

Density: low

Fuming point: 78°c

Note: The experiment was conducted on a Soxhlet apparatus again to verify the outcome measurement. The acidity value experiment was conducted on the oil sample after 24 hours of extraction to assure that there are no remaining solvents with careful storing and handling.

3rd Sample: Flaxseed by organic farming

The sample of ground seeds was 72.38 grams, a solvent of 700ml of n-hexane AR was added to the sample with hours of continuous magnetic shaking

Observation:

After adequate shaking time, the sample went through filtration process and finally solvent was evaporated on the rotary evaporator to obtain the crude oil sample.

Net sample was: 16.5 grams of pure oils.

Color: Yellow color

Density: low

Fuming point: 95°c fast oxidation

Note: the experiment was conducted on a soxhlet apparatus again to verify the outcome measurement.

Acidity Value experiment was conducted on the oil sample after 24 hours of extraction to assure that there are no remaining solvent with careful storing and handling.

Experiment: Acidity tests were conducted multiple times to obtain reliable data.

4th Sample: Flaxseeds by conventional farming

The sample of ground seeds was 89.50 grams, a solvent of 900ml of n-hexane AR was added to the sample with hours of continuous magnetic shaking.

Observation:

After adequate shaking time, the sample went through filtration process and finally solvent was evaporated on the rotary evaporator to obtain the crude oil sample. **(Abdalbasit, 2016)**

Net sample was: 15 grams of pure oils

Color: Yellow color

Density: low

Fuming point: 98.9°c fast oxidation

Note: The experiment was conducted on a Soxhlet apparatus again to verify the outcome measurement.

Acidity Value experiment was conducted on the oil sample

After 24 hours of extraction to ensure that there are no remaining solvents with careful storing and handling.

Experiment: Acidity test was conducted multiple times to obtain reliable data.

RESULTS

Lab Analysis:

Acidity Value:

Sample1:

Experiment:

Acidity tests were conducted multiple times to obtain reliable data.

A sample of 0.82gram of oils was weighed.

Potassium hydroxide of 0.1 normality was prepared.

Neutral ethanol was added to the weighed oil samples with phenolphthalein indicator, then result was obtained after titration with KOH 0.1 when pink color appeared and confirmed.

Calculations:

Acidity Value= $(0.1 \times 0.3 \times 56.11) \div 0.82 = 2.05$

Acidity percentage= 2.05÷2= 1.02%
Free Fatty Acid %= 2.05÷1.99=1.25%

Second fat extraction method was by Soxhlet apparatus

Sample2:

Experiment:
Acidity tests were conducted multiple times to obtain reliable data.
A sample of 1.27gram of oils was weighed.
Potassium hydroxide of 0.1 normality was prepared.
Neutral ethanol was added to the weighed oil samples with phenolphthalein indicator, then result was obtained after titration with KOH 0.1 when pink color appeared and confirmed.

Calculations:
Acidity Value= (0.1×0.2×56.11)÷1.27 = 0.88
Acidity percentage= 0.88÷2= 0.44%
Free Fatty Acid %= 0.88÷1.99=0.44%

Sample 3:

A sample of 0.66 gram of oils was weighed.
Potassium hydroxide of 0.1 normality was prepared.
Neutral ethanol was added to the weighed oil samples with phenolphthalein indicator, then result was obtained after titration with KOH 0.1 when pink color appeared and confirmed.

Calculations:
Acidity Value= (0.1×0.1×56.11)÷0.66 = 0.85
Acidity percentage= 0.85÷2= 0.42%
Free Fatty Acid %= 0.85÷1.99=0.42%

Sample4:

A sample of 1.55 gram of oils was weighed.
Potassium hydroxide of 0.1 normality was prepared.
Neutral ethanol was added to the weighed oil samples with phenolphthalein indicator, then result was obtained after titration with KOH 0.1 when pink color appeared and confirmed.

Calculations:
Acidity Value= (0.1×0.6×56.11)÷1.55= 2.172
Acidity percentage= 2.172÷2= 1.086%
Free Fatty Acid %= 2.172÷1.99=1.0914%
Acidity Value= (N×V×56.11)÷W
N is the normality of KOH
V is the titration volume
W is the oil sample weight

Moisture percentage:

Moisture content was calculated in the 4 samples; seeds from organic and conventional sources were thoroughly ground and weighed on a petri dish. Petri dishes were also weighed as empty and with the samples; ground seeds were placed inside the oven for 3 hours at 100°c then let to cool down inside a desiccator for 15 minutes. Samples are then weighed to notice the difference in weight before and after oven drying. Finally samples were placed in the oven for another half an hour till the weight remained fixed and calculations were conducted to get the moisture percentage. **(Negash et al., 2019)**

Sample1: conventional farming poppy seeds.
Dish: 115.45 grams
Sample + dish= 135.09 grams
Sample1 plus dish after drying: 133.95 grams
Moisture content= (135.09 – 133.95)÷ 19.65= 0.058

Sample 2: conventional farming flax seeds
Empty dish: 65.69 grams
Dish plus sample: 76.98grams
Sample plus dish after drying= 76.25 grams
Moisture content= (76.98-76.29)÷11.29=0.061

Sample 3: Organic Flaxseed
Empty dish= 70.29 grams
Dish plus sample= 82.54 grams
Dish + sample after drying: 81.73 grams
Moisture content= (82.54-81.73)÷12.25= 0.066

Sample 4: Organic Poppy seed:
56.46 gm empty petri dish
80.81 poppy seeds plus petri dish
79.36 gm after drying, petri plus poppy seeds
Moisture content= (80.81-79.36)÷24.35= 0.06

Oil percentage in the seeds: **(Mohadeseh Kiani a et al., 2020)**

Sample1: Poppy Seeds by conventional farming
Weight of oil= 19,13 grams of oil
Weight of ground sample= 85 grams
Oil content=(19.13÷85)×100= 22.5%
Sample 2: Organic Poppy seed
Weight of oil=7.92 grams of oil
Wight of ground sample= 91.2 grams
Oil content=(7.92÷91.2)×100= 8.68%
Sample3: Flaxseed by organic farming
Wight of oil=16.5 grams of crude oil

Wight of ground sample= 72.38 gm of sample
Oil content=(16.5÷72.38)×100= 22.8%
Sample4: Flaxseeds by conventional farming
Weight of oil: 15 grams of oil
Weight of sample= 89.50 grams of ground sample
Oil content%= (15÷89.50) ×100= 16.8%

Table 1. Table illustrating Moisture content in the 4 groups of seeds.

Samples	Conventional Poppy seeds	Conventional Flaxseeds	Organic Poppy Seeds	Organic Flaxseeds
Moisture content	**0.058**	**0.061**	**0.06**	**0.066**
Moisture %	**5.8%**	**6.1%**	**6%**	**6.6%**

Table 2. Table representing Acid values of the oils as well as Fuming point and organoleptic.

Samples	Conventional Poppy seeds	Conventional Flaxseeds	Organic Poppy seeds	Organic Flaxseeds
Density	**High**	**Low**	**Low**	**Low**
Fuming point	**73°c**	**98.9°c**	**78°c**	**95°c**
Acidity %	**1.02%**	**1.1%**	**0.44%**	**0.42%**
F.F.A %	**1.25%**	**1.1%**	**0.44%**	**0.42%**
Oil Color	**Dark brown (not clear)**	**Yellow**	**Light brown (clear)**	**Yellow**

Table 3. Table to indicate the percentage of oil in each type of seeds.

Samples	Conventional Poppy seeds	Conventional Flaxseeds	Organic Poppy seeds	Organic Flaxseeds
Oil content %	**22.5%**	**16.8%**	**8.68%**	**22.8%**

Discussion

In terms of acidity values, organic seeds were more superior in terms of oil quality and free fatty acids. As per organoleptic tests; organic seeds showed better oil color, taste and smell. As per fuming points and moisture contents, they were the same in both sources. Oil content was higher in organic flaxseeds than in their conventional counterpart, whereas surprisingly Conventional Poppy seeds had higher content of oils than organic seeds, however further analysis would be essential to determine heavy metal and chemical residues.

ALA alpha-linoleic Acid PUFA is more predominant in flaxseed than Poppy seed; Poppy seed is rich in MUFA oils.

Both have low antioxidant content and low fuming points due to the high prevalence of PUFA and MUFA, that's why they need fortification by other natural antioxidants because they are easily oxidized. They also require delicate storage in cool temperatures with preferably dark well-enclosed bottles.

It goes without saying that poppy seed oil as well as flaxseed oil cannot be used as cooking oils or in commercial oil extraction, due to their high sensitivity to oxidation either by heat, light or moisture. In contrast, seeds are preferred to be used as a whole due to high nutritional values; they are rich in protein and fibers, more importantly they contain healthy fats, as in PUFA (Polyunsaturated fatty acids) and MUFA (monounsaturated fatty acids), which are considered a superfood ingredients that fight against chronic diseases, e.g. Cardiovascular diseases, Diabetes 2 and Alzheimer disease. Furthermore, oils possess high anti-inflammatory functions, so in order to get the best out of the seed's benefits; they must be cultivated in an organic way.

CONCLUSION

Integrated organic farming is a definitive key to achieving food security as well as sustainable diet solutions; by which diet is healthy, nutritious, affordable, and available throughout the year and without environmental footprints. Regenerative organic farming incorporates Sustainable Development Goals 1, 2, 3, 12 and 13 which are: No Poverty, Zero Hunger, Good Health, Responsible Consumption & production, and Climate Action. Organic farming has regenerated the destroyed soil for several decades now. This approach doesn't resort to any chemical pesticides, insecticides or fertilizers which deteriorate human health; moreover food became lower in nutritional quality; dense in carbohydrates and low in essential micronutrients and macronutrients. The study provided evidence-based expert opinion summary which supported moving towards integrated organic farming. The panel of experts supported their opinion with real-life experiments from the land and with over 300 workshops to farmers and landlords which happen in a carousel annually. In addition to that, as per lab analysis: oils extracted from the organic seeds (Poppy seeds and flaxseeds) showed promising results compared to conventionally farmed seeds, in terms of acidity and organoleptic results. Although moisture and fuming results were more or less the same in both sources, it is recommended that more analysis will be conducted in regards of oil contents in organic farming produce with more food technology and biotechnology approaches to enrich food with more superfood components as in polyunsaturated fatty acids (PUFA) and monounsaturated fatty acids (MUFA).

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Disclaimer:

All organic seeds were purchased with organic USDA label and non-EU Agriculture.