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Oil Technologists' Association of India (North Zone)

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Editor-in-chief desk..............

Dear Friends,

As we step into 2025, the lipid science community stands at a remarkable crossroads of technological innovation, new product development and sustainability. This issue of *Lipid Universe* reflects the dynamic frontiers our industry continues to explore for a greater satisfaction of consumer, industries and other stake holders.

From the extraordinary world of Black Soldier Fly larvae oil, a true marvel of bioconversion, may be tailored to explore similar opportunities in India, and it can be an important tool in India's ambitious biofuel journey. The articles in this issue underscore that the future of lipids extends far beyond the kitchen and into energy, medicine, and environmental stewardship.

The trade landscape is equally eventful. Shifting geopolitical currents - from Chinese tariffs on Canadian rapeseed to Pakistan's agricultural transformation through Chinese technology - are reshaping global oilseed flows in ways that demand our close attention.

On the health front, the growing science around omega-3 and omega-7 fatty acids, the promise of theobromine in cocoa, and plant-based innovations like sunflower protein remind us that lipids remain central to human wellness.

I am hopeful about the depth the depth of knowledge this issue brings to our readers - researchers, industry professionals, and enthusiasts alike.

Stay curious. Stay connected.

Yours truly
C.S. Joshi
Editor-in-chief

Editor-in-chief desk..............

Editor's desk..............

Dear Readers,

You have heard of many oils, but have you heard of Larval oil; which is produced from Black soldier flies. They born through a four-stage life cycle - egg, larva, pupa and adult - starting when a female lays roughly 500-900 eggs near decaying organic matter. The eggs hatch in 3-4 days into larvae, which consume waste rapidly for about 14-18 days, then pupate and emerge as adults in 1-2 weeks to mate, completing the cycle in 45 days.

The Black soldier fly is not a pest, a power-house of bio-remediation. Through a process known as bio-con version, the larvae shows benifits in two distinct high value areas: reducing volume of organic waste, and producing oil. The larvae transform the decomposing waste into high quality biomass rich in protein and fat/oil, all the while reducing the waste volume by upto 80%.This conversion of waste into protein and lipid can replace fish meal and soybean meal.

The larvae oil is rich in medium chain saturated fatty acids, particularly lauric acid which makes it ideal for producing high -quality biodiesel that meets international fuel standards. The study shows that the high temperature aqueous extraction is the best extraction method than other sovent methods which yields higher oil content.

India is aggressively pursuing a 5% biodiesel blending target by 2030 to curb crude imports and emissions, focusing on non-edible oils and waste-to-energy projects; while targeting 20% ethanol blending by 2030. However, the sector faces critical bottlenecks : inconsistent feedstock availability, high production costs relative to conventional diesel, limited logistics for used cooking oil (UCO) collection, and technological challenges in large-scale conversion.

This issue also includes trade news, important PSD (production, supply and demand) data of oilseeds and their products along with the health news. Recently, Omega-5s like Omega-3s, are fatty acids known as punicic acid which is a long chain polyunsaturated fatty acid found in certain seed oils like pomegranates. Punicic acid's antioxidative and anti- inflammatory effects are being explored for the prevention and treatment of neurodegenerative diseases. Reports say, more research is needed for an optimal dosage for health benefits.

Geranium essential oil is prized for its ability to balance sebum production in both oily and dry skin, provide soothing anti-inflammatory support, and offer natural antimicrobial protection.

The Theobroma Cacao plant, historically revered as the "food of the gods" in the confectionary industry. The theobromine, a bitter alkaloid present in the cacao plant, that acts as a powerful bioactive compound, offering numerous health benefits to humans, including cardiovascular protection, potential anti-aging effects, and mood enhancement when taken dark chocolate at the dose of 300-600 mg.

Yours truly

Dr. S. Adhikari
Editor

Editor's desk...............

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PHYSICOCHEMICAL PROPERTIES AND FATTY ACID PROFILE OF OIL EXTRACTED FROM BLACK SOLDIER FLY LARVAE (*HERMETIA ILLUCENS*)

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Abstract

Background and Aim: *Hermetia illucens*, a black soldier fly, is widely recognized for sustainable recycling of organic waste. Black soldier fly larvae (BSFLs) can consume various types of biowastes and convert them into nutrient-rich biomass, including proteins, lipids, chitin, and minerals. This study investigated the best extraction method by comparing the fatty acid profiles, percentage yield, and antioxidant properties of BSFL oil extracted using different extraction methods.

Materials and Methods: The physicochemical properties, fatty acid profile, and free radical scavenging ability of BSFL oil were analyzed using six extraction methods.

Results: Ultrasonic extraction with hexane resulted in the highest yields compared with different extraction methods. Lauric acid (28%–37%) was the most abundant fatty acid in all extracts, followed by palmitic acid, myristic acid, oleic acid, and linoleic acid. Compared with other methods, aqueous extraction showed the highest lauric acid composition and free radical scavenging activities. In addition, high-temperature aqueous extraction resulted in higher oil yield and free radical scavenging activities than low-temperature extraction.

Conclusion: High-temperature aqueous extraction is the best extraction method because it is rich in lauric acid, has antioxidant ability, and can be further developed to produce novel sustainable biomaterials for humans and animals.

Keywords: black soldier fly, extraction method, fatty acid, *Hermetia illucens*.

Introduction

Antioxidants play an important role in free radical scavenging both *in vivo* and *in vitro* [1]. Antioxidant substances can be found in various food products, such as vegetables and oils, and their consumption can reduce the risk of chronic diseases [2]. The use of synthetic antioxidants such as butylated hydroxytolu-ene (BHT), butylated hydroxyanisole, propyl gallate, and citric acid in food processing has recently led to an increased occurrence of side effects (e.g., carcino-genesis) [3]. Thus, there has been an increase in the number of studies focusing on natural antioxidants over the past decade [4]. The black soldier fly, *Hermetia illucens* L. (*Diptera*: *Stratiomyidae*), specifically the black soldier fly larvae (BSFL), has received increased attention from scientists because BSFL can consume a diverse range of organic waste materials and is of nutri-tional benefit

[5]. The nutritional composition of BSFL depends on the rearing substrate; in general, it contains 40% protein and 30% fat on a dry matter basis [6, 7]. However, nutritional biomass can vary depending on the type of growing substrate [8]. Natural oils contain various important fatty acids and are extensively used in cosmetics and skin treatments worldwide [9]. Oil quality primarily depends on its fatty acid composition [10]. Previous studies have found that BSFL oil is rich in saturated fatty acids (SFAs), mainly lauric acid [11, 12], which exhibits antioxidant, antibacterial, anti-viral, antifungal, and anticancer properties [7, 13, 14]. These observations are in agreement with those of a recent study showing that BSFL oil has antioxidant activities without causing toxicity in *Artemia salina* [11]. Moreover, broiler chickens fed with BSFL oil exhibited improved immune and antioxidant functions in the blood plasma [15]. Fatty acid profiles, extraction yields, and antioxidant properties of oils can vary depending on the extraction method employed [16].

Conventional oil extraction processes include solvent extraction, mechanical pressing, and aque-ous extraction [17]. Solvent extraction (e.g., hexane [H] and ethanol [E]) has a high oil yield and easy recovery [18]. However, the use of these organic sol-vents has led to increased concerns about their impact on general health and environmental protection. For example, H is released into the environment to form ozone and photochemicals [17]. H and E are readily soluble in neural lipids [17, 19]. Moreover, several studies have revealed that H and E inhalation affects the neural system. Because of these health, safety, and environmental concerns, there has been a search for sub-stitutes for organic solvents. Other alternatives include much simpler and safer methods that involve fewer steps, such as the mechanical pressing method [20]. However, drawbacks such as relatively high energy demand and low efficiency make the mechanical press-ing method less popular [21]. Aqueous extraction is an eco-friendly alternative process that eliminates the use of organic solvents and requires lower investment costs and energy demand [18]. Therefore, aqueous extraction is gaining popularity to obtain high-quality oils, such as palm oil, peanut oil, and larval oil [11, 21, 22].

Therefore, this study aimed to investigate the best extraction method by comparing the fatty acid profiles, percentage yield, and antioxidant properties of BSFL oil extracted using different extraction methods. In addition, we update the fatty acid profiles of BSFL oil. The findings of this study could be used for the production and development of dietary products and sustainable biomaterials.

Materials and Methods

Ethical approval

The research conducted adhered to the Guidelines for the Care and Use of Laboratory Animals. The eth-ics committee of Kasetsart University Research and Development Institute, Kasetsart University, Thailand, approved this study (ID: ACKU66-SCI-021).

Study period and location

This study was conducted for eight months (November 2022 to June 2023). BSFL was cultivated on a domestic farm in Pathum Thani Province, Thailand. The physicochemical and free radical scavenging ability of BSFL oil were conducted at Department of Zoology, Faculty of Science, Kasetsart University. The fatty acid profile of BSFL oil analysis was conducted at Department of Chemistry Faculty of Science, Kasetsart University.

Reagents

2,2-diphenyl-1-picrylhydrazyl (DPPH) and 2,22 -azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS), ethyl acetate, and ethyl alcohol were obtained from MilliporeSigma (Burlington, MA, USA) and Thermo Fisher Scientific (Waltham, MA, USA), respectively. Potassium persulfate was procured from PanReac AppliChem (Barcelona, Spain). H was purchased from Macron Fine Chemicals (Radnor, PA, USA). All reagents and chemicals used were of analytical grade.

BSFL cultivation and preparation

BSFL was cultivated on a domestic farm in Pathum

Thani Province, Thailand. Larvae were raised in 60 × 40 × 10 cm plastic containers in controlled environments (28 ± 2°C on a 12-h light/12-h dark cycle) Larvae were fed a mixture of coconut endosperm and soybean curd residue in a 50:50 ratio at a humidity of 70% [5]. The BSFL prepupa obtained from the culture was sieved and washed to remove any feed. The BSFL preparations were then frozen and kept at –20°C until the experiment was performed.

Samples were prepared using the method described by Krzy¿aniak *et al*. [23]. Briefly, to stop the browning reaction, the frozen BSFL prepupa was blanched in boiling water for 35 s. Subsequently, the larvae were thinly spread on an aluminum tray (500 g larvae per tray) and baked under convective hot air. Baking was performed at 65°C for 6 h to ensure that the larvae achieved full dryness and were subsequently crushed in a grinder. Crushed larvae were then placed in Ziploc bags and stored at 20°C until use.

Oil extractions

Aqueous extraction using a magnetic stirrer

Aqueous extraction with a magnetic stirrer was performed based on the method described by Yashashri *et al*. [24] with slight modifications. In brief, 70 g of crushed larvae was extracted with 195 mL of distilled water in a beaker with a magnetic stirrer for 15 min. This setup was run at 45°C (M45), 65°C (M65), and 95°C (M95). The extract was centrifuged at 2200× *g* for 15 min. The lipid layer formed at the top was col-lected, weighed, and stored at room temperature until further analysis.

Mechanical pressing and extraction

Mechanical pressing extraction (M) was per-formed based on the method described by Rabadán *et al*. [25] with slight modification; extraction was performed using a Stainless Steel SUS304 single screw press (Siam Wealth Food, Co. Ltd., Nonthaburi, Thailand). The dried BSFL was pressed using a rotat-ing screw press at an extraction temperature of 150°C. The maximum machine capacity load was 5 kg/h. The extracts were collected, weighed, and stored at room temperature for further analysis.

Ultrasonic extraction using an organic solvent

Ultrasonic extraction with organic solvents was performed according to the method described by Almeida *et al*. [11] with slight modifications. Extraction was performed using n-H and E organic solvents. Crushed larvae (70 g) in 195 mL of solvent were subjected to a 15-min cold ultrasonic treatment (Cole-Parmer, Vernon Hills, IL, USA) before timed agitation. Subsequently, the extract was centrifuged at 2200× *g* for 15 min. We collected the liquid layer at the top and removed the solvent on a rotary vacuum evaporator (R-215, Buchi, Bangkok, Thailand) at 50°C. The obtained extracts were collected, weighed, and stored at room temperature for further analysis.

Physicochemical properties

Extraction yield (%)

The amount of oil extracted through each method was weighed to calculate the extraction yield using Equation 1.

$$\text{Extraction yield (\%)} = (\text{Oil weight}/\text{Sample weight}) \times 100 \quad (1)$$

Color intensity

The color intensities of the oil samples were determined using an Ultraviolet–vis spectrophotometer (Spark™ 10M, TECAN, Mannedorf, Switzerland). Oil was placed in a 96-well plate, and absorbance was recorded at a wavelength of 425 nm. Each sample was analyzed in triplicate.

Fatty acid composition

Following the method of Buthelezi *et al*. [26] with slight modifications; Fatty acid methyl ester (FAME) analysis was performed using a gas chromatography-mass spectrometer (GCMS-QP2020, Shimadzu, Kyoto, Japan) with a fatty acid methyl ester column (ZB-FAME, Zebron, Newport Beach, CA, USA) with a length of 30 m, an internal diameter of 0.25 mm, and a stationary phase film thickness of 0.20 ?m to determine the fatty acid composition in the BSFL oil. One ìL of the derivatized sample was injected in split mode at a split ratio of 1:50 using He (99.999%) as the carrier gas at a constant flow rate of 1 mL/min. The injector and interface temperatures were set to 240°C and 260°C, respectively. The oven temperature was programmed from 40°C to 150°C, then 2°C/min to 170°C, and held for 7 min, then ramped at a rate of 10°C/min to 200°C, increased to 240°C at 20°C/min, and kept again for 2 min to elute any remaining impurities. The total run time was 35 min, and the fatty acids were identified by compar-ing their retention times with those of authentic stan-dard fatty acid methyl esters. An electron ionization system with an ionizing energy of 70 eV and an ion source at 240°C was used for GC/MS detection.

Free radical scavenging activity of the BSFL oil

DPPH radical scavenging assay

The DPPH assay was performed on the basis of the method described by Srisuksai *et al.* [27] with slight modifications. If a hydrogen atom or electron is transferred to the DPPH radical (DPPH), then the absorbance at 517 nm decreases proportionally to the increase in the number of non-radical forms of DPPH. Briefly, 50 ?L of each BSFL oil extracted using differential methods was added to 150 ?L of DPPH in ethyl acetate (150 ?M). The absorbance at 517 nm decreased proportionally with an increase in the number of non-radical particles. After vortex mix-ing, the mixture was incubated at room temperature for 30 min, and absorbance was measured at 517 nm. BHT was used as a positive control, and all samples were tested in triplicate. We documented the differ-ences in the absorbance of each oil, BHT, and control (DPPH only). Radical scavenging activity was calcu-lated as the percentage inhibition using the following equation:

% inhibition = [(control test)/control] × 100 (2)

The half-maximal inhibitory concentration (IC_{50}) was determined as the oil concentration that elicited a 50% decrease in absorbance compared with the control.

ABTS radical scavenging assay

The ABTS assay was performed on the basis of the method described by González-Palma *et al*. [28], with slight modifications. This assay is based on decolorization, which occurs when the radical cation ABTS+ is reduced to ABTS. Briefly, 7 mM ABTS solution and 2.45 mM potassium persulfate solution were used as the stock solutions. The working solu-tion was then prepared by mixing equal quantities of the two stock solutions and allowed to react for 16 h at room temperature in the dark. After incubation, the solution was further diluted at water: E ratio of (1:1) until an initial absorbance value of 0.7 0.1 at 734 nm was achieved. Fresh ABTS solution was prepared for each assay. BSFL oil extracted using various meth-ods (20 ?L) was allowed to react with 180 ?L of the ABTS solution, and absorbance was measured at 734 nm after 60 min using a spectrophotometer. BHT was used as a positive control, and all samples were tested in triplicate. We documented the differences in the absorbance of BSFL oil extracted using various methods, BHT, and control (ABTS only). Radical scavenging activity was calculated as the percentage inhibition using the following equation:

% inhibition = [(control test)/control] × 100 (3)

The half-maximal IC50 was defined as the con-centration of oil that elicited a 50% decrease in absor-bance compared with the control.

Statistical analysis

Statistical analyses were performed using the R Statistical Software (v4.1.2; R core team, 2021; https://www.r-project.org/) [29]. Data are presented as mean standard deviation. All data were analyzed using a one-way analysis of variance followed by Tukey's *post hoc* test. A p = 0.05 was considered statistically significant.

Results

Physicochemical properties of the BSFL oil

The percentage yields of BSFL oil obtained through various aqueous extractions with mag-netic stirrers (M45, M65, and M95), M, ultrasonic extraction with H, and E were 1.11 ± 0.55, 3.15 ± 0.63, 5.86 ± 0.90, 16.82 ± 2.58, 21.19 ± 1.40, and 14.52 ± 2.46, respectively (Figure-1). When com-pared with the other extraction methods used in this study, extraction with H gave the highest yield.

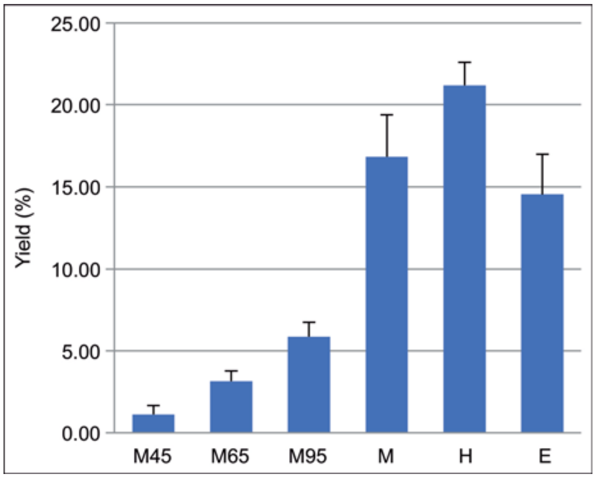

Figure-1: Yield obtained from different extraction methods. Values with a different letter above the bar differ significantly ($p < 0.05$). M45=aqueous extraction with a magnetic stirrer at the temperature of 45°C, M65=Aqueous extraction with a magnetic stirrer at the temperature of 65°C, M95=Aqueous extraction with a magnetic stirrer at temperature of 95°C, M=Mechanical pressing extraction, H=Ultrasonic extraction with hexane, E=Ultrasonic extraction with ethanol.

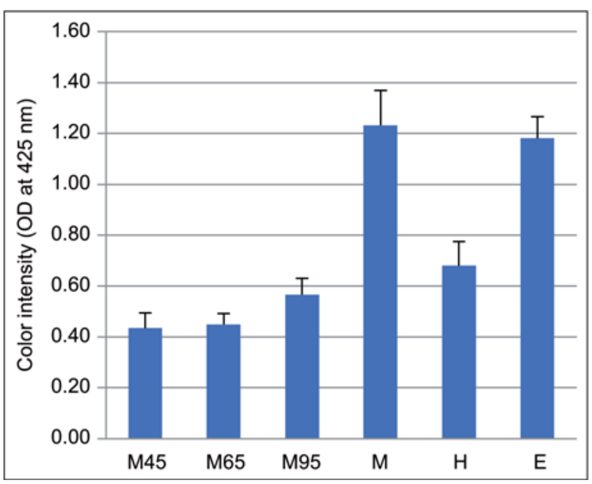

Figure-2: Color intensity of BSFL oils extracted using various methods. Values with a different letter above the bar differ significantly ($p < 0.05$). M45=Aqueous extraction with a magnetic stirrer at temperature of 45°C, M65=Aqueous extraction with a magnetic stirrer at temperature of 65°C, M95=Aqueous extraction with a magnetic stirrer at temperature of 95°C, M=Mechanical pressing extraction, H=Ultrasonic extraction with hexane, E=Ultrasonic extraction with ethanol, BSFL=Black soldier fly larvae.

The color intensity after BSFL oil extraction using various methods indicated that the extracted samples exhibited a yellow color when compared with the blank value (Optical density = 0.0480). The yellow color intensity of the oil obtained using the M and E methods was significantly higher than that obtained using the M45, M65, M95, and H methods ($p < 0.05$; Figure-2).

Fatty acid profiles of BSFL oil

Fatty acid profiles of BSFL oil extracted using the E method had significantly higher levels of total SFAs than those extracted using the M45, M65, M95, M, and H methods ($p < 0.05$; Table-1). In addition, oil extracted using the E method had significantly lower levels of total monounsaturated fatty acids ($p < 0.05$; Table-1). However, the BSFL oil extracted using the E method did not have a total polyunsaturated fatty acid (PUFA) content. The total PUFA content in BSFL oil extracted using the M95 (13.81 ± 0.60%) and M (12.97 ± 0.85%) methods was significantly higher ($p < 0.05$) than that extracted using the M65 (9.36 ± 1.58%). The unsaturated fatty acid (UFA)/SFA ratio in BSFL oil extracted by the M95 (0.48 ± 0.01), M (0.48 ± 0.01), and H (0.45 ± 0.03) methods was significantly higher ($p < 0.05$) than that extracted by the M65 (0.36 ± 0.05%) and E (0.01 ± 0.00) methods ($p = 0.05$).

Free radical scavenging activity of BSFL oil using the DPPH assay

Figure-3 presents the free radical scavenging activity of the BSFL oil extracted using different methods. Oil extracted using the M45, M65, M95, M, H, and E methods showed a dose-dependent inhibi tory effect on DPPH free radical scavenging ability (Figure-3a). The IC_{50} (in mg/mL) of BSFL oil extracted using the M45, M65, M95, M, H, and E methods, including BHT, was 53.28 ± 1.88, 104.90 ±6.11, 38.24 ± 7.79, 9.06 ± 0.16, 32.89 ± 7.14, 9.59 ± 1.64, and 1.53 ± 0.08, respectively (Figure-3b). The DPPH free radical scavenging ability of the

BSFL oils extracted using different methods and BHT was in the order BHT > M > E > H > M95 > M45 > M65.

Free radical scavenging activity of BSFL oil using the ABTS assay

Figure-4 presents the free radical scavenging activity of the BSFL oil extracted using different methods. A dose-dependent inhibitory effect on the ability to scavenge ABTS free radicals was observed for BSFL oil extracted using the M45, M65, M95, M, H, and E methods (Figure-4a). The IC_{50} (in mg/mL) of BSFL oil extracted using the M45, M65, M95, M, H, and E methods, including BHT, was 285.41 ± 13.46, 242.17 ± 11.88, 146.58 ± 17.06, 243.04 ± 21.54, 244.87 ± 14.77, 233.51 ± 10.07, and 0.19 ± 0.02, respectively (Figure-4b). The ability of BSFL oils to scavenge ABTS free radicals was in the order BHT > M95 > E > M65 > M > H > M45.

Discussion

The black soldier fly is one of the most interest-ing insects because of its ability to bioconvert organic wastes, such as agricultural waste, animal farm waste, and house organic waste, into high biomass and sus-tainable biological products. Insect production is inex-pensive and environmentally friendly, given several feeding sources, high land-use efficiency, and reduc-tion of greenhouse gasses [30]. Previous studies have Values in the same row with different superscript letters differ significantly ($p < 0.05$). M45=Aqueous extraction with a magnetic stirrer at temperature of 45°C, M65=Aqueous extraction with a magnetic stirrer at temperature of 65°C, M95=Aqueous extraction with a magnetic stirrer at temperature of and 95°C, M=mechanical pressing extraction, H=Ultrasonic extraction with hexane, E=Ultrasonic extraction with ethanol, PUFA=Polyunsaturated fatty acid, MUFAs=Monounsaturated fatty acid, SFA=Saturated fatty acid, UFA=Unsaturated fatty acid indicated that BSFL can reduce biomass by 30%–50%, thereby converting it into high-quality nutrients that can be used as feed for domestic animals, exotic foods, and fish and poultry [31, 32].

In the present study, we focused on the BSFL oil

Table-1: Fatty acid composition of BSFL oil analyses through gas chromatography.

Fatty acids	Fatty acid composition (%)					
	M45	M65	M95	M	H	E
Capric acid (C10:0)	1.01 ± 0.04^{b}	1.00 ± 0.06^{b}	0.92 ± 0.05^{bc}	0.80 ± 0.06^{c}	0.86 ± 0.03^{bc}	1.25 ± 0.07^{a}
Lauric acid (C12:0)	34.13 ± 0.47^{ab}	32.93 ± 2.78^{bc}	30.88 ± 1.32^{bcd}	28.39 ± 2.17^{d}	29.44 ± 0.74^{cd}	37.82 ± 1.03^{a}
Tridecanoic acid (C13:0)	0.12 ± 0.07	0.05 ± 0.01	0.04 ± 0.00	0.04 ± 0.01	0.07 ± 0.05	0.06 ± 0.00
Myristic acid (C14:0)	15.81 ± 0.75^{b}	16.13 ± 1.16^{b}	14.22 ± 0.45^{bc}	12.46 ± 0.61^{c}	13.57 ± 0.32^{c}	20.50 ± 0.83^{a}
Pentadecanoic acid (C15:0)	0.15 ± 0.01^{cd}	0.16 ± 0.01^{bc}	0.14 ± 0.00^{d}	0.18 ± 0.01^{b}	0.15 ± 0.01^{cd}	0.23 ± 0.01^{a}
Palmitic acid (C16:0)	15.80 ± 1.01^{b}	16.54 ± 0.96^{b}	14.65 ± 0.55^{b}	16.73 ± 0.74^{b}	15.91 ± 0.31^{b}	23.09 ± 0.98^{a}
Margaric acid (C17:0)	-	0.14 ± 0.00^{ab}	0.13 ± 0.01^{b}	0.20 ± 0.03^{ab}	0.18 ± 0.07^{ab}	0.26 ± 0.08^{a}
Stearic acid (C18:0)	2.88 ± 0.22^{d}	3.07 ± 0.15^{cd}	2.75 ± 0.09^{d}	3.95 ± 0.15^{b}	3.33 ± 0.04^{c}	4.40 ± 0.18^{a}
Nonadecanoic acid (C19:0)	-	-	-	-	0.09 ± 0.01	-
Total SFA	69.90 ± 1.55^{b}	70.01 ± 5.10^{b}	63.72 ± 2.44^{b}	62.75 ± 3.71^{b}	63.52 ± 1.30^{b}	87.62 ± 3.14^{a}
Palmitoleic acid (C16:1)	1.44 ± 0.15^{a}	1.10 ± 0.15^{ab}	1.44 ± 0.24^{a}	0.75 ± 0.03^{b}	0.89 ± 0.27^{b}	-
Petroselinic acid (C18:1 *n*-12)	1.26 ± 0.28^{cd}	1.83 ± 0.46^{ab}	1.14 ± 0.20^{cd}	2.54 ± 0.21^{a}	1.74 ± 0.25^{ab}	0.57 ± 0.22^{d}
Oleic acid (C18:1 *n*-9)	14.48 ± 0.96	12.78 ± 1.04	14.10 ± 1.32	13.66 ± 0.36	13.66 ± 0.97	-
Total MUFA	16.76 ± 0.40^{a}	15.71 ± 0.83^{a}	16.69 ± 1.38^{a}	16.95 ± 0.60^{a}	16.29 ± 0.48^{a}	0.57 ± 0.22^{b}
Linoleic acid (C18:2 *n*-6)	10.17 ± 0.93^{ab}	8.61 ± 1.40^{b}	11.89 ± 1.54^{a}	11.84 ± 0.80^{ab}	11.08 ± 1.22^{ab}	-
alpha-Linolenic acid (C18:3 *n*-3)	0.87 ± 0.16^{ab}	0.75 ± 0.18^{b}	1.24 ± 0.23^{a}	1.13 ± 0.06^{ab}	1.06 ± 0.16^{ab}	-
Total PUFA	11.04 ± 1.09^{ab}	9.36 ± 1.58^{b}	13.81 ± 0.60^{a}	12.97 ± 0.85^{a}	12.14 ± 1.37^{ab}	-
Other	2.30 ± 0.16	4.91 ± 3.97	6.46 ± 5.51	7.34 ± 5.08	8.05 ± 2.76	11.81 ± 3.30
UFA/SFA	0.40 ± 0.03^{ab}	0.36 ± 0.05^{b}	0.48 ± 0.01^{a}	0.48 ± 0.01^{a}	0.45 ± 0.03^{a}	0.01 ± 0.00^{c}

Values in the same row with different superscript letters differ significantly ($p < 0.05$). M45=Aqueous extraction with a magnetic stirrer at temperature of 45°C, M65=Aqueous extraction with a magnetic stirrer at temperature of 65°C, M95=Aqueous extraction with a magnetic stirrer at temperature of and 95°C, M=mechanical pressing extraction, H=Ultrasonic extraction with hexane, E=Ultrasonic extraction with ethanol, PUFA=Polyunsaturated fatty acid, MUFAs=Monounsaturated fatty acid, SFA=Saturated fatty acid, UFA=Unsaturated fatty acid

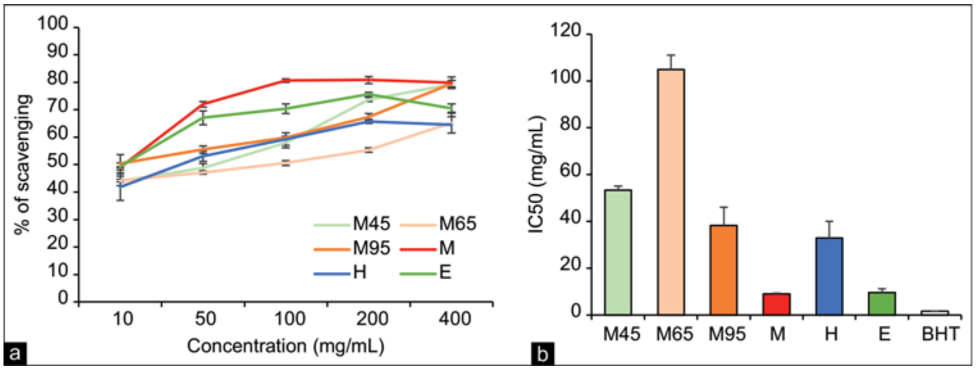

Figure 3: Free radical scavenging of BSFL oils extracted using various methods using the DPPH assay. (a) Free radical scavenging ability. (b) IC_{50} of BSFL oil extracted by M45, M65, M95, M, H, E, and BHT. Values are presented as mean SD. M45=Aqueous extraction with a magnetic stirrer at temperature of 45°C, M65=Aqueous extraction with a magnetic stirrer at temperature of 65°C, M95=Aqueous extraction with a magnetic stirrer at temperature of 95°C, M=Mechanical pressing extraction, H=Ultrasonic extraction with hexane, E=Ultrasonic extraction with ethanol, BSFL=Black soldier fly larvae, DPPH=2,2-diphenyl-1-picrylhydrazyl.

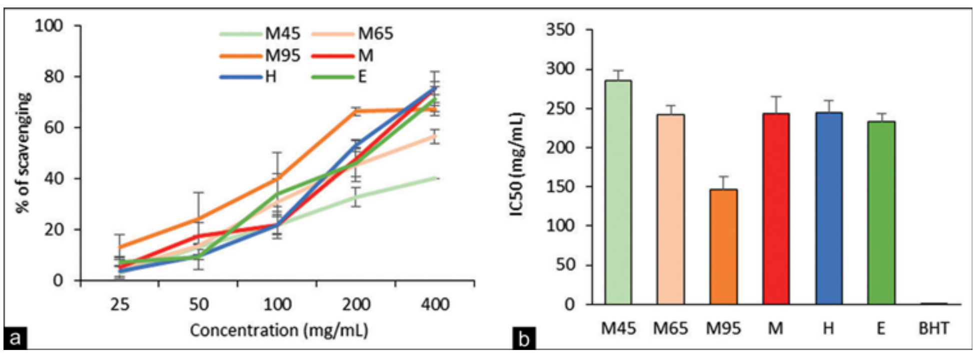

Figure-4: Free radical scavenging of BSFL oils extracted using various methods using the ABTS assay. (a) Free radical scavenging ability. (b) IC_{50} of BSFL oil extracted by M45, M65, M95, M, H, E, and BHT. Values are presented as mean SD. M45=Aqueous extraction with a magnetic stirrer at temperature of 45°C, M65=Aqueous extraction with a magnetic stirrer at temperature of 65°C, M95=Aqueous extraction with a magnetic stirrer at temperature of 95°C, M=Mechanical pressing extraction, H=Ultrasonic extraction with hexane, E=Ultrasonic extraction with ethanol, BSFL=Black soldier fly larvae, ABTS=2,22 -azino-bis(3-ethylbenzothiazoline-6-sulfonic acid), SD=Standard deviation.

extraction method and demonstrated that it affected both the percent extraction yield and the physico-chemical properties of the oil. Organic solvents commonly used for lipid extraction include H, 3:2 H-isopropanol, chloroform, 2:1 chloroform-methanol, and methyl-tert-butyl-ether [33], depending on the sample polarity. Organic solvents can extract different classes of compounds according to their polarity [11]. This explains the higher extraction percentage for H and E compared with the other extraction meth-ods used in this study (Figure-1). In addition, oil extraction with H yielded higher yields than that with E (Figure-1). H has a lower polarity than E [34]. As the polarity of the solvent decreases, the oil extraction yield increases [35]. This finding is in agreement with previous studies in which oil extracted by hexane gave the highest yield [11, 36, 37].

The BSFL oil obtained using the M and E meth-ods had a yellow color higher than that obtained using the M45, M65, M95, and H methods (Figure-2). Hydraulic compression-producing oil (M method) showed a yellow cloudy oil, which may be due to the pigment content [38, 39]. The high polarity of E is capable of extracting nonglyceride components such as phosphatides, sterols, tocopherols, and pigments [40]. This finding is in agreement with previous stud-ies in which E-based solvents appear slightly more colored [41, 42]. Similar to a previous study by Wu *et* *al*. [43], our study found that the color of the BSFL oil extracted by the aqueous method is clear yellow. In addition, the clear yellow of oil extracted by the H method is most likely due to bleaching [39].

Our results showed that SFAs are the major com-ponent of all BSFL oil extracts (Table-1). Among the SFAs, lauric acid had the highest abundance, in agree-ment with previous reports [32, 44], with the highest yield obtained using E extraction. UFAs were almost absent in the BSFL oil extracted with E (Table-1). A rotary evaporator was used to separate the oil from the solvents in ultrasonic extraction with organic solvents. The vacuum pressure for the rotary evapo-ration of E is lower than that for H. The intermolec-ular attraction of UFAs is weaker than that of SFAs, leading to a lower boiling point [45]. Therefore, UFAs may evaporate to the bottom of the solvent, leaving only SFAs in the BSFL oil extracted with E. Fatty acid profiles were present in all BSFL oil extracts in the following order: Lauric acid, palmitic acid, myris-tic acid, oleic acid, and linoleic acid [11, 32, 44]. Similar to a previous study by Almeida [11] and He *et al*. [46], our study demonstrated that the SFAs in aqueous extraction were higher than those in mechan-ical and H extraction. Different fatty acid composi-tions may be due to oxidation during the extraction process, extraction techniques, and the fatty acid structure [39]. In addition, previous studies have sug-gested that the extraction method temperature affects the fatty acid concentration [47, 48]. High extraction temperatures could trigger the degradation of free fatty acids into volatile components [48]. Similar to a previous study by Mohamed *et al*. [49], our study found that increasing temperature reduced the concentration of lauric acid. However, the fatty acid profile of the BSFL oil also depends on the substrate used to rear the BSFL [50, 51]. BSFL reared with fermented maize

stover has the lowest lauric acid content, whereas BSFL reared with vegetable and fruit waste has the highest lauric concentration [32]. Other studies have indicated that a high concentration of carbohydrates in foods can increase the lauric acid content of BSFL oil, suggesting that BSFL can metabolize carbohydrates into lauric acid [6, 51].

The ability of BSFL oil to scavenge free radi-cals was determined using DPPH and ABTS *in vitro* antioxidant assays. Similar to a previous study by Phongpradist *et al*. [52], our results indicated that BSFL oil could scavenge free radicals [52]. In both the DPPH and ABTS assays, the BSFL oil extracted with E had a higher free radical scavenging ability than the oil extracted using other methods (Figures-3 and 4). E is highly capable of extracting nonglyceride com-ponents such as phosphatides, sterols, tocopherols, and pigments [40]. Previous studies by Dos Santos Aquilar [53] have shown that tocopherols in insect lar-val oil may contribute to antioxidant capacity by acting as a chain-breaking agent. In addition, compared with the other methods, BSFL oil extracted by mechanical pressing showed the highest free radical scavenging ability in the DPPH assay (Figure-3). To obtain nat-ural oil products, the pressing method is based only on a mechanical process [54]. Therefore, the pressing method is a rich source of phytosterols, tocopherols, carotenoids, and polyphenols that are associated with antioxidant capacity [55, 56]. According to previous studies, the pressing method has advantages with regard to the retention of active components to scav-enge free radicals both *in vivo* and *in vitro* [57, 58]. However, aqueous extraction of BSFL oil at 95°C resulted in higher free radical scavenging in both DPPH and ABTS assays compared with aqueous extraction at 45°C and 65°C (Figures-3 and 4). An earlier study demonstrated that an increase in water temperature reduces surface tension and viscosity, which increases the diffusion and mass transfer rates during extraction [59]. Previous studies have demonstrated that aqueous extraction with boiling water contains more antioxi-dant compounds than cool water [60, 61]. Similar to our study, a previous study by Thuanthong *et al*. [59] found that increasing the extraction temperature from 70°C to 80°C leads to higher DPPH and ABTS radi-cal scavenging activities [59]. The DPPH scavenging activity was found to be higher than the ABTS cation scavenging activity (Figures-3 and 4). Stereoselectivity of the radicals or solubility of the extract in different testing systems could affect the capacity of extracts to react and scavenge different radicals [62, 63].

Most researchers are looking for new sources of proteins, lipids, or sustainable biological resources. A high concentration of lauric acid in the BSFL oil indicates its potential use, which is similar to that of coconut oil and palm kernel oil [36]. Several studies have shown that lauric acid has antibacterial, antiviral, antifungal, and anticancer activities [7, 13, 14]. Moreover, lauric acid is widely used as a raw material for the production of surfactants in the food, cosmetic, shampoo, and pharmaceutical industries [7]. Palmitic, myristic, oleic, and linoleic acids constituted the fatty acid profile of the BSFL oil. Several studies have indi-cated the beneficial properties of fatty acids, such as myristic acid, which can function as a skin penetra-tion enhancer [64] and are used as a cosmetic ingre-dient [32], oleic acid, which regulates epidermal lipid metabolism [64], palmitic acid and its derivatives as emollients, and linoleic acid, which contributes to the water impermeability of the stratum cornel [11].

Conclusion

Although ultrasonic extraction using organic sol-vents (H and E) yielded the highest oil yields, health and the environment are of concern. However, aque-ous extraction yielded the highest amount of lauric acid compared with other methods. Interestingly, aqueous extraction at a high temperature (M95) yielded higher oil yields and free radical scavenging activities compared with lower temperatures (M45 and M65). Therefore, we conclude that high-temperature aqueous extraction is the best extraction method in this study. The quality of the BSFL oil thus obtained can ensure its use as a sustainable bionutrient, biomedical material, and phar-maceutical substance. Further studies are required to increase the effectiveness of the extraction methods dis-cussed and the purity, quality, and quantity of BSFL oil.

Authors' Contributions

KS: Performed the experiment, analyzed the data, and wrote the manuscript. PL, UK, KT, and AK: Performed the experiment and edited the manuscript. WI, RL, and TS: Provided and analyzed fatty acid profile and edited the manuscript. WF: Conceived, designed and supervised the study and edited the man-uscript. All authors have read, reviewed, and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

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TRADE NEWS

Chinese agricultural technology transforms oilseed harvesting landscape in Pakistan

A farmer uses a newly imported oilseed harvester to harvest canola at a field in Pakistan's eastern Bhakkar district on April 17, 2024. (Xinhua/Ahmad Kamal)

Chinese technology unlocks a crucial opportunity to transform Pakistan's agricultural landscape, as advanced oilseed harvesters can swiftly enhance efficiency and productivity, marking a significant step towards the country's goal of becoming self-sufficient in edible oil production.

by Misbah Saba Malik, Jiang Chao ISLAMABAD, April 23 (Xinhua) -- In Pakistan's eastern Bhakkar district, farmers were left in awe as they witnessed the newly imported oilseed harvesters from China efficiently and briskly carrying out their tasks.

"In Pakistan, we lose up to 40 percent of our crop due to our reliance on a single type of harvester used for harvesting all crops including wheat, oilseeds, and others, so seeing such a sophisticated machine specifically designed for oilseed harvesting is truly fascinating," Muhammad Masood, a local farmer told Xinhua.

While Pakistan is an agricultural-centric economy, it relies on imports for approximately 89 percent of its edible oil needs and spends 3.6 billion U.S. dollars annually to fulfill the demand of around 5 million tons.

Due to the high cost of imported edible oil, many villagers had to resort to cheaper but unhealthy alternatives such as mustard oil because of the unavailability of good quality oil seeds in the local market, he said.

Farmers carry harvested canola at a field in Pakistan's eastern Bhakkar district on April 17, 2024. (Xinhua/ Ahmad Kamal)

However, with the introduction of the Chinese canola variety into the market under Pakistan-China cooperation, the local farmers finally got a choice, the farmer added.

Launched in 2013, the China-Pakistan Economic Corridor (CPEC) is a corridor linking the Gwadar Port in southwest Pakistan's Balochistan province with Kashgar in northwest China's Xinjiang Uygur Autonomous Region, which highlights energy, transport, and industrial cooperation in the first phase, while in the new phase expands to fields of agriculture and livelihood, among others.

In line with the CPEC's cooperation in agriculture, Chinese company Wuhan Qingfa Hesheng Seed Co. Ltd. and Pakistani company Evyol Group signed a memorandum of understanding in 2022 to help Pakistan become self-sufficient in edible oil through ample cultivation and efficient harvest of healthy canola oilseeds.

Talking to Xinhua, Ghazanfar Ali, head of marketing in Evyol Group, said that in the first phase, the Chinese company provided high-quality hybrid seed for cultivation, which not only increased per acre yield as compared to local oilseeds but also provided a healthy alternative to locals.

A farmer uses a newly imported oilseed harvester to harvest canola at a field in Pakistan's eastern Bhakkar district on April 17, 2024. (Xinhua/Ahmad Kamal)

In the second phase, the company is working on transferring technology to Pakistan, under which the harvesters have been imported from China, paving the way for smart agriculture practices in the country, said Ali.

Subsequent plans for the third phase involve importing oil-extracting machines, which will enable local farmers to extract the oil themselves for domestic consumption and commercial use, he added.

Talking about the new machines, Zhou Xusheng, director of the international business department of Wuhan Qingfa Hesheng Seed company, told Xinhua that they have developed two kinds of harvesting equipment that align with local cultivation and use habits.

One of the equipment enables one-time harvesting, slashing harvest loss to eight to ten percent while the other offers a two-stage approach, which involves cutting the crop close to maturity and picking it up two to three days later, reducing loss to less than five percent, he added.

The technological advancement can boost yields by 20 to 30 percent, thereby enhancing farmers' incomes and accelerating widespread adoption, compatible with existing harvesters in Pakistan, Zhou said.

Farmers harvest canola at a field in Pakistan's eastern Bhakkar district on April 17, 2024. (Xinhua/Ahmad Kamal)

The harvesters will be further customized according to the requirements of locals, after feedback from local farmers and agriculture experts, following which the bulk import of the equipment will be made, Ali told Xinhua.

He underscored CPEC's role in elevating socio-economic standards by empowering farmers to embrace advanced technology.

"Through technology transfer, CPEC empowers local farmers to not only reduce labor and costs but also increase their earnings, enabling them to lead more prosperous lives, besides giving benefit to society as a whole," he said.

Talking about the significance of the technology transfer, Akmal Siddiq, technical advisor at the country's Ministry of National Food Security and Research said that during the oilseed harvest season, there is a shortage of labor in the agriculture sector as almost all winter crops are being harvested during the time.

The available labor is also not so skilled and when they harvest the crop by primitive measure, the overall productivity of the sector gets affected, he added.

"The adoption of Chinese agricultural technology represents a critical opportunity to modernize and transform the oilseed harvesting landscape in the country. Through effective technology transfer and adoption, the agricultural sector can overcome longstanding challenges, boost productivity, and contribute to the nation's food security and economic development," the official told Xinhua.

Source: Xinhua

Chinese buyers switch to cheaper Brazilian soybeans ahead of Trump return

Chinese soybean processors have turned to competitively priced Brazilian cargoes instead of U.S. oilseeds, amid fears Washington will impose import tariffs after President-elect Donald Trump takes office on Jan. 20.

Worries about revived trade tensions during Trump's second administration have already disrupted trade flows to China, the world's biggest agricultural goods importer, prompting buyers to stockpile inventories and seek alternative suppliers.

Source: Reuters

Idemitsu to begin trial of non-edible oilseed crop for aviation fuel

Idemitsu Kosan will begin a trial plantation of the non-edible oilseed tree crop Pongamia in Australia from mid-January to assess its potential as a feedstock for sustainable aviation fuel (SAF), Japan's No.2 crude oil refiner said on Thursday.

The plantation will be conducted in collaboration with Terviva, a U.S. company with over a decade of research and cultivation expertise in Pongamia, Idemitsu said in a statement.

Pongamia, a leguminous plant distributed in Southeast Asia and Oceania, is a highly efficient non-edible oilseed crop that does not compete with food production, according to Idemitsu.

Idemitsu, aiming to establish a supply system for 500,000 kilolitres of SAF annually by 2030, said it has also invested in Terviva, it said, but did not disclose the investment details.

Through the trial plantation, Idemitsu will evaluate long-term cultivation methods for Pongamia and how to optimize the supply chain from cultivation to SAF production.

Idemitsu will also explore additional uses for Pongamia, including creating carbon credits through afforestation, producing biomass power pellets from Pongamia shells, and using pressed oilseed cake as livestock feed.

Oil extracted from its seeds is expected to serve as a feedstock for sustainable aviation fuel production, the company said.

SAF is considered crucial for the aviation sector to reach its goal of net zero carbon emissions by 2050, but its adoption remains in a nascent phase.

SAF makes up only around 0.3% of global jet fuel usage and is projected to reach just 0.7% by 2025, according to data from airline trade body IATA. Experts emphasize that the production rate of the green fuel needs to grow quickly for the sector to achieve its emissions targets.

Source: Reuters

Minnesota approves hemp seed meal as feed for laying hens, expanding market potential

Hemp seed meal may now be fed to Minnesota's laying hens, state agriculture officials recently announced.

Also referred to as hempseed "cake," the feed material was tentatively approved by the Association of American Feed Control Officials (AAFCO) last year, meaning individual states could move forward with commercial adoption. The meal is obtained by grinding or milling the cake after most of the oil has been extracted from hemp seeds. It is now listed in AAFCO's official publication, the foundational document for the feed industry that provides definitions, regulations, and procedures related to ingredients, labeling, and manufacturing.

The Minnesota Department of Agriculture (MDA) said the state is among the first in the nation to approve commercialization of the feed material. Minnesota allows tentatively approved ingredients to be used in animal feed and pet food. Hemp meal is restricted to laying hens for now, and can make up no more than 20% of the birds' diet as a source of protein and fat, the MDA said.

Expanding the market

"It's an opportunity to expand the availability of hemp in the market," said Daniel King, an MDA feed specialist and board member of AAFCO.

"Producers can market it as a specialty ingredient."

Rich in protein, essential fatty acids, and fiber, hemp seed meal offers nutritional benefits for laying hens, cattle, and other farm animals. Studies suggest that including hemp seed meal in diets can improve egg quality in hens, enhance growth performance in cattle, and support overall animal health due to its omega-3 and omega-6 content.

More research coming

The Food and Drug Administration set the final standards with a limit of 2 parts per million (ppm) for THC and 20 ppm for cannabidiol CBD. More research and testing will take place over the next year to make sure the THC and CBD levels in the hemp seed are "correct," according to MDA.

The AAFCO process may take a year or more before moving from tentative approval to full approval for an ingredient, King said. Once full approval is granted, it could be expanded to meal uses for other animals, he said.

Source: Hemp Today

Chinese rapeseed meal, oil contracts surge after tariffs on Canadian imports

Beijing | Reuters — Zhengzhou rapeseed (canola) meal and oil contracts jumped on Monday, the first day of trade since China decided to impose 100 per cent tariffs on imports of those products from Canada.

The most-active rapeseed meal futures on the Zhengzhou exchange climbed six per cent to close at 2,611 yuan (C$518) per metric ton – the biggest daily rise since September 2022.

Why it matters: China represents a massive market for Canadian agricultural products

Canada's exports of rapeseed oil, oil cakes and peas were worth roughly $1 billion (C$1.44 billion) last year. The tariffs, effective March 20, come in tandem with a 25 per cent duty on Canadian aquatic products and pork, worth $1.6 billion (C$2.3 billion) in 2024. The levies follow 100 per cent and 25 per cent tariffs Canada imposed on Chinese-made electric vehicles and steel last year.

The new tariffs are expected to raise the cost of Canadian canola oil, easing domestic oversupply pressure and helping to stabilize rapeseed oil prices, said China Grain Net, an information provider affiliated with state stockpiler Sinograin. However, analysts say the price spike may not last long.

"China has alternative origins for rapeseed oil such as Russia and the EU and also the Chinese import duty hike could pressure Canadian canola prices, resulting in a sharp decline in product prices," said Anilkumar Bagani, research head of Mumbai-based vegetable oil broker Sunvin Group. "It also needs to be noted that China has huge rapeseed oil stocks at the moment and the crush capacity utilization is also considerably high," Bagani said.

Additionally, China's Zhengzhou Commodity Exchange said it will raise the minimum order size per trade for some rapeseed meal futures contracts to 10 lots from one lot previously, starting from the night trading session on Monday.

The exchange increased the minimum order size to reduce retail investor participation and avoid price fluctuations caused by a large number of small orders, said Xuan Dongshuang, an analyst at research firm Sublime China Information. China last year began an anti-dumping investigation into Canadian canola, but canola was not included among the tariffs announced on Saturday, just rapeseed meal and oil.

This likely leaves room for negotiation during trade talks, traders and analysts said. The anti-dumping investigation on canola has reduced direct imports in the first quarter this year, with imported canola meal expected to make up over 50 per cent of total supply, China Grain Net said.

"However, once the investigation concludes, imports of Canadian rapeseed meal are likely to drop, leading to tighter supply," it added.

Source: Alberta Farmar Express

IMPORTANT FIGURES

Table 01: Soybeans: World Supply and Distribution

Thousand Metric Tons

	2021/22	2022/23	2023/24	2024/25
Production				
Brazil	130,500	162,000	154,500	172,500
United States	121,504	116,221	113,273	119,047
Argentina	43,900	25,000	48,210	51,108
China	16,395	20,284	20,840	20,650
Paraguay	4,183	10,250	11,000	10,200
India	11,889	12,411	11,875	12,582
Russia	4,760	5,996	6,800	7,050
Other	27,407	26,198	29,904	35,015
Total	360,538	378,360	396,402	428,152
Imports				
China	90,297	104,500	112,000	108,000
European Union	14,545	13,127	13,550	14,710
Argentina	3,839	9,059	7,787	6,324
Mexico	6,397	6,451	6,457	6,434
Egypt	4,566	1,993	3,321	4,543
Thailand	3,243	3,238	3,428	4,190
Turkey	2,949	2,888	3,252	4,183
Japan	3,455	3,332	3,099	3,243
Vietnam	1,839	1,858	2,265	2,609
Taiwan	2,622	2,559	2,577	2,768
Other	21,015	19,497	20,799	22,187
Total	154,767	168,502	178,535	179,191
Exports				
Brazil	79,063	95,504	104,170	103,142
United States	58,570	53,864	46,266	51,227
Argentina	2,861	4,185	5,114	7,874
Paraguay	2,273	6,495	7,987	6,405
Canada	4,289	4,240	4,861	5,551
Other	7,366	7,470	9,364	10,006
Total	154,422	171,758	177,762	184,205
Crush				
China	90,000	96,000	99,000	103,500
United States	59,980	60,199	62,196	66,546
Brazil	50,767	53,409	54,405	58,162
Argentina	38,825	30,318	36,583	43,236
European Union	15,400	14,300	14,500	15,400
India	8,500	10,300	11,300	11,000
Mexico	6,350	6,650	6,530	6,650
Russia	4,900	5,400	5,900	6,225
Egypt	4,500	2,200	3,250	4,500
Paraguay	2,200	3,450	3,000	3,700
Bolivia	3,100	3,300	2,600	3,225
Thailand	2,500	2,100	2,400	2,700
Ukraine	1,300	1,500	1,800	2,800
Iran	2,500	3,000	2,700	2,850
Turkey	1,800	1,700	2,300	2,850
Other	23,871	21,933	22,781	25,903
Total	316,493	315,759	331,245	359,247
Ending Stocks				
China	25,146	32,341	43,311	44,489
Brazil	27,378	36,819	29,761	37,688
Argentina	23,691	16,997	24,047	23,569
UnitedStates	7,468	7,190	9,319	8,840
European Union	1,572	1,262	1,300	1,568
Other	8,384	7,214	7,387	8,653
Total	93,639	101,823	115,125	124,807

Foreign Agricultural Service/USDA Global Market Analysis

Table 02: Soybean Meal: World Supply and Distribution

Thousand Metric Tons

	2021/22	2022/23	2023/24	2024/25
Production				
China	71,280	76,032	78,408	81,972
United States	47,005	47,621	49,084	53,019
Brazil	39,091	41,488	41,859	44,383
Argentina	30,287	23,648	28,535	33,724
European Union	12,166	11,297	11,455	12,166
India	6,800	8,240	9,040	8,800
Mexico	5,020	5,255	5,159	5,255
Other	36,364	34,798	36,502	42,731
Total	248,013	248,379	260,042	282,050
Imports				
European Union	16,473	15,997	16,564	20,609
Vietnam	5,531	4,724	6,027	5,703
Indonesia	5,535	5,434	5,055	6,179
Philippines	2,897	2,824	2,967	3,189
Iran	1,362	1,185	2,985	2,805
Thailand	3,077	3,141	2,770	2,939
Mexico	1,827	1,670	1,935	2,345
United Kingdom	2,015	1,762	1,976	2,529
Colombia	1,831	1,603	1,585	2,030
Ecuador	1,775	1,771	1,891	2,100
Other	24,890	23,138	25,850	27,287
Total	67,213	63,249	69,605	77,715
Exports				
Argentina	26,589	20,764	24,891	29,780
Brazil	20,207	21,334	22,722	23,390
UnitedStates	12,303	13,196	14,564	16,570
Bolivia	2,167	2,155	1,509	2,000
Paraguay	1,270	1,992	1,683	2,176
Other	6,304	7,619	8,775	9,149
Total	68,840	67,060	74,144	83,065
Domestic Consumption				
China	71,100	75,050	77,150	80,850
United States	35,323	34,946	35,068	37,231
European Union	27,742	26,642	27,042	31,242
Brazil	19,700	20,000	20,000	20,500
Vietnam	6,235	5,785	6,640	7,295
Mexico	6,875	6,930	7,080	7,450
India	6,273	6,625	7,075	7,000
Indonesia	5,550	5,580	5,200	5,900
Iran	3,500	3,550	4,810	5,100
Thailand	4,900	4,750	4,575	4,800
Russia	3,500	3,650	3,900	4,100
Egypt	3,700	2,700	3,000	3,800
Argentina	3,325	3,450	3,500	3,525
Japan	3,610	3,550	3,521	3,500
Philippines	2,950	2,930	3,000	3,220
Other	41,542	40,909	43,505	47,374
Total	245,825	247,047	255,066	272,887
Ending Stocks				
Brazil	3,657	3,817	2,972	3,470
Argentina	2,797	2,298	2,443	3,141
European Union	595	510	836	1,717
China	710	937	794	943
Turkey	417	422	466	572
Other	8,489	6,202	7,112	8,593
Total	16,665	14,186	14,623	18,436

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Table 03: Soybean Meal: World Supply and Distribution

Thousand Metric Tons

	2021/22	2022/23	2023/24	2024/25
Production				
China	16,128	18,240	18,810	20,100
United States	11,864	11,897	12,289	13,253
Brazil	10,153	10,580	11,055	11,842
Argentina	7,664	5,991	7,251	8,626
European Union	2,926	2,717	2,755	2,926
India	1,530	1,854	2,034	1,980
Mexico	1,171	1,227	1,205	1,227
Other	8,575	8,218	8,610	10,135
Total	60,011	60,724	64,009	70,089
Imports				
India	4,231	3,968	3,308	5,471
Canada	63	147	573	637
Bangladesh	689	703	649	943
European Union	458	641	592	757
Morocco	659	640	593	626
Peru	471	535	560	612
Algeria	530	490	485	564
Korea, South	392	353	447	482
Colombia	317	242	317	384
China	291	395	381	296
Other	3,540	3,019	2,713	3,404
Total	11,641	11,133	10,618	14,176
Exports				
Argentina	4,873	4,137	5,533	7,099
Brazil	2,408	2,687	1,352	1,487
European Union	959	915	659	708
Russia	665	750	760	750
Paraguay	371	523	497	621
United States	803	171	280	1,131
Ukraine	235	277	345	523
Other	2,115	2,285	2,381	2,890
Total	12,429	11,745	11,807	15,209
Domestic Consumption				
China	17,100	17,900	18,900	20,500
United States	11,262	12,070	12,317	12,197
Brazil	7,700	8,300	10,200	10,410
India	5,825	5,400	5,175	6,645
European Union	2,305	2,405	2,630	3,005
Argentina	2,650	1,660	1,770	1,980
Mexico	1,300	1,305	1,270	1,310
Bangladesh	1,100	975	1,010	1,200
Canada	240	320	685	750
Egypt	960	560	510	730
Algeria	750	750	765	780
Iran	850	900	725	525
Pakistan	525	360	285	620
Korea, South	600	565	600	650
Morocco	630	630	600	625
Other	6,044	5,433	5,541	6,420
Total	59,841	59,533	62,983	68,347
Ending Stocks				
China	387	1,011	1,198	776
India	186	597	748	1,527
United States	903	729	703	792
European Union	563	601	659	629
Argentina	526	720	670	324
Other	2,757	2,243	1,760	2,399
Total	5,322	5,901	5,738	6,447

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Table 04: Soybean Meal: World Supply and Distribution

Thousand Metric Tons

	Marketing-Year	Meal, Soybean		Oil, Soybean		Oilseed, Soybean	
		2023/24	2024/25	2023/24	2024/25	2023/24	2024/25
Exports							
North America		14,895	16,883	516	1,299	51,135	56,778
South America		50,806	57,355	7,827	9,808	120,185	121,198
South Asia		1,969	1,804	16	32	9	12
India	(Oct-Sep)	1,966	1,781	16	27	8	12
Other		6,474	7,023	3,448	4,070	6,433	6,217
World Total		74,144	83,065	11,807	15,209	177,762	184,205
Imports							
European Union	(Oct-Sep)	16,564	20,609	592	757	13,550	14,710
East Asia		3,602	3,425	946	914	118,799	115,144
China	(Oct-Sep)	31	45	381	296	112,000	108,000
Japan	(Oct-Sep)	1,822	1,621	2	1	3,099	3,243
Korea, South	(Oct-Sep)	1,664	1,725	447	482	1,118	1,128
Taiwan	(Oct-Sep)	85	34	0	0	2,577	2,768
Southeast Asia		18,548	19,910	274	288	9,118	10,128
Indonesia	(Oct-Sep)	5,055	6,179	34	34	2,567	2,439
Malaysia	(Oct-Sep)	1,279	1,426	89	92	683	727
Philippines	(Jan-Dec)	2,967	3,189	56	55	149	136
Thailand	(Sep-Aug)	2,770	2,939	0	0	3,428	4,190
Vietnam	(Jan-Dec)	6,027	5,703	80	90	2,265	2,609
North America		3,905	4,525	955	974	7,359	7,473
Canada	(Aug-Jul)	1,347	1,448	573	637	335	250
United States	(Oct-Sep)	623	732	282	164	567	789
Canada	(Aug-Jul)	1,347	1,448	573	637	335	250
Mexico	(Sep-Aug)	1,935	2,345	100	173	6,457	6,434
South America		7,222	8,486	1,508	1,781	9,549	8,025
Argentina	(Oct-Sep)	1	279	2	107	7,787	6,324
Brazil	(Oct-Sep)	18	5	80	85	867	731
Paraguay	(Jan-Dec)	0	0	3	3	6	4
Brazil	(Oct-Sep)	18	5	80	85	867	731
Colombia	(Oct-Sep)	1,585	2,030	317	384	447	561
Central America		1,744	2,078	193	213	293	320
Caribbean		853	881	279	271	36	17
Middle East		8,263	8,220	146	224	6,995	9,069
Iran	(Oct-Sep)	2,985	2,805	22	26	2,554	2,693
Israel	(Oct-Sep)	249	311	6	2	285	266
Syria	(Jan-Dec)	173	100	2	2	1	1
Turkey	(Oct-Sep)	1,554	1,350	0	0	3,252	4,183
North Africa		1,986	2,222	1,148	1,286	5,540	6,710
Egypt	(Oct-Sep)	468	395	37	50	3,321	4,543
Other Europe		2,470	3,139	192	200	1,452	1,757
United Kingdom	(Oct-Sep)	1,976	2,529	182	190	976	1,079
Other		4,448	4,220	4,385	7,268	5,844	5,838
World Total		69,605	77,715	10,618	14,176	178,535	179,191

Foreign Agricultural Service/USDA Global Market Analysis

Table 05: Palm Oil: World Supply and Distribution

Thousand Metric Tons

	2021/22	2022/23	2023/24	2024/25
Production				
Indonesia	42,000	45,000	43,000	45,500
Malaysia	18,152	18,389	19,710	19,380
Thailand	3,376	3,321	3,274	3,330
Colombia	1,762	1,853	1,875	1,900
Nigeria	1,400	1,400	1,500	1,500
Other	6,630	6,754	6,735	6,807
Total	73,320	76,717	76,094	78,417
Imports				
India	8,004	10,045	8,886	7,786
China	4,387	6,190	4,377	3,203
Pakistan	2,734	3,094	2,980	3,325
EuropeanUnion	5,201	4,576	4,013	3,135
Bangladesh	1,339	1,610	1,676	1,540
UnitedStates	1,588	1,887	1,864	1,541
Egypt	1,155	1,052	1,171	1,301
Vietnam	995	1,112	1,071	1,076
Philippines	1,154	892	1,083	1,577
Kenya	789	848	875	811
Other	14,132	14,861	13,860	15,775
Total	41,478	46,167	41,856	41,070
Exports				
Indonesia	22,321	28,077	22,273	23,471
Malaysia	15,527	15,355	16,530	15,617
Thailand	971	902	878	1,302
PapuaNewGuinea	834	813	669	747
Guatemala	792	883	620	566
Other	3,433	3,337	3,440	3,322
Total	43,878	49,367	44,410	45,025
DomesticConsumption				
Indonesia	17,425	19,125	21,075	22,375
India	8,150	8,900	8,990	8,800
Malaysia	3,300	3,975	3,667	4,165
China	5,100	5,400	5,000	3,300
Pakistan	2,845	2,995	3,070	3,250
EuropeanUnion	5,000	4,500	3,890	3,200
Thailand	2,335	2,485	2,485	2,135
Nigeria	1,715	1,790	1,840	1,940
Bangladesh	1,470	1,600	1,575	1,540
Colombia	1,380	1,500	1,555	1,530
UnitedStates	1,561	1,875	1,894	1,524
Egypt	1,175	1,060	1,160	1,250
Philippines	1,270	1,000	1,040	1,485
Vietnam	927	1,037	1,007	1,040
Brazil	840	825	920	950
Other	14,763	15,286	15,386	16,937
Total	69,256	73,353	74,554	75,421
EndingStocks				
Indonesia	7,309	5,108	4,761	4,416
Malaysia	2,318	2,312	2,014	2,360
India	972	2,419	2,615	1,898
Colombia	826	856	842	717
China	420	1,181	546	439
Other	4,948	5,081	5,165	5,154
Total	16,793	16,957	15,943	14,984

Foreign Agricultural Service/USDA Global Market Analysis

Table 06: Rapeseed and Products: World Supply and Distribution

Thousand Metric Tons

	Marketing Year	Meal, Rapeseed		Oil, Rapeseed		Oilseed, Rapeseed	
		2023/24	2024/25	2023/24	2024/25	2023/24	2024/25
Production							
China	(Oct-Sep)	11,684	11,861	7,722	7,839	15,800	15,800
India	(Oct-Sep)	6,219	6,189	3,975	3,956	11,600	11,520
Canada	(Aug-Jul)	6,408	6,710	4,706	4,821	19,464	19,239
Japan	(Oct-Sep)	1,188	1,231	910	884	4	3
European Union	(Jul-Jun)	13,908	13,509	10,248	9,954	20,431	17,073
Other		9,803	9,784	6,825	6,818	22,675	22,609
World Total		49,210	49,284	34,386	34,272	89,974	86,244
Imports							
China	(Oct-Sep)	2,842	2,810	2,039	2,171	5,486	4,600
India	(Oct-Sep)	17	21	6	26	0	0
Canada	(Aug-Jul)	3	1	19	16	276	131
Japan	(Oct-Sep)	5	4	8	23	2,117	2,138
European Union	(Jul-Jun)	839	420	463	295	5,457	7,964
Other		6,224	6,891	4,963	4,549	4,924	5,115
World Total		9,930	10,147	7,498	7,080	18,260	19,948
Exports							
China	(Oct-Sep)	7	32	21	19	0	0
India	(Oct-Sep)	1,609	1,870	10	13	0	0
Canada	(Aug-Jul)	5,652	5,855	3,444	3,327	6,812	9,387
Japan	(Oct-Sep)	0	8	4	5	0	0
European Union	(Jul-Jun)	874	880	746	585	534	382
Other		2,073	2,085	3,292	3,198	11,210	10,053
World Total		10,215	10,730	7,517	7,147	18,556	19,822
Domestic Consumption							
China	(Oct-Sep)	14,519	14,639	9,700	10,350	20,675	20,925
India	(Oct-Sep)	4,600	4,360	3,980	4,005	11,650	11,550
Canada	(Aug-Jul)	725	870	1,250	1,330	11,628	11,673
Japan	(Oct-Sep)	1,126	1,245	911	895	2,116	2,134
EuropeanUnion	(Jul-Jun)	13,900	13,100	9,950	9,700	25,150	24,350
Other		13,819	14,575	8,557	8,091	17,487	17,785
World Total		48,689	48,789	34,348	34,371	88,706	88,417
Ending Stocks							
China	(Oct-Sep)	0	0	1,609	1,250	4,784	4,259
India	(Oct-Sep)	224	204	393	357	569	539
Canada	(Aug-Jul)	168	154	550	730	3,166	1,476
Japan	(Oct-Sep)	83	65	30	37	187	194
European Union	(Jul-Jun)	402	351	309	273	1,938	2,243
Other		623	638	566	644	1,294	1,180
World Total		1,500	1,412	3,457	3,291	11,938	9,891

Foreign Agricultural Service/USDA Global Market Analysis

Table 07: Sunflowerseed and Products: World Supply and Distribution

Thousand Metric Tons

	Marketing Year	Oilseed, Sunflowerseed		Meal, Sunflowerseed		Oil,Sunflowerseed	
		2023/24	2024/25	2023/24	2024/25	2023/24	2024/25
Production							
Argentina	(Mar-Feb)	3,895	5,592	1,687	2,143	1,673	2,119
Russia	(Sep-Aug)	17,100	16,900	6,780	6,698	6,815	6,732
Turkey	(Sep-Aug)	1,550	1,350	872	995	696	795
Ukraine	(Sep-Aug)	15,500	13,000	6,484	5,080	6,751	5,290
European Union	(Oct-Sep)	10,051	8,645	4,973	4,108	3,887	3,212
Other		7,833	7,527	2,444	2,438	2,297	2,317
World Total		55,929	53,014	23,240	21,462	22,119	20,465
Imports							
Argentina	(Mar-Feb)	1	1	0	0	0	0
Russia	(Sep-Aug)	65	80	5	5	1	1
Turkey	(Sep-Aug)	328	789	1,312	1,042	1,491	1,236
Ukraine	(Sep-Aug)	20	22	13	1	1	1
European Union	(Oct-Sep)	832	582	3,238	2,567	3,022	2,411
Other		1,296	1,137	5,591	4,130	9,446	8,360
World Total		2,542	2,611	10,159	7,745	13,961	12,009
Exports							
Argentina	(Mar-Feb)	73	624	1,157	1,657	1,198	1,686
Russia	(Sep-Aug)	375	200	2,650	2,400	4,400	4,200
Turkey	(Sep-Aug)	102	174	45	53	1,189	1,001
Ukraine	(Sep-Aug)	314	68	4,653	3,418	6,264	4,744
European Union	(Oct-Sep)	447	824	955	479	990	691
Other		1,409	1,481	759	812	1,302	1,387
World Total		2,720	3,371	10,219	8,819	15,343	13,709
Domestic Consumption							
Argentina	(Mar-Feb)	4,087	5,227	615	500	562	562
Russia	(Sep-Aug)	16,980	16,800	4,125	4,300	2,525	2,575
Turkey	(Sep-Aug)	1,802	2,027	2,175	2,000	1,440	1,090
Ukraine	(Sep-Aug)	15,875	12,825	1,525	1,800	430	440
European Union	(Oct-Sep)	10,250	8,630	7,110	6,260	5,513	5,213
Other		7,673	7,397	7,310	5,731	10,598	9,231
World Total		56,667	52,906	22,860	20,591	21,068	19,111
Ending Stocks							
Argentina	(Mar-Feb)	820	562	207	193	244	115
Russia	(Sep-Aug)	717	697	407	410	237	195
Turkey	(Sep-Aug)	142	80	187	171	169	109
Ukraine	(Sep-Aug)	176	305	566	429	134	241
European Union	(Oct-Sep)	567	340	457	393	699	418
Other		776	562	307	332	1,409	1,468
World Total		3,198	2,546	2,131	1,928	2,892	2,546

Foreign Agricultural Service/USDA Global Market Analysis

Table 08: Minor Vegetable Oils: World Supply and Distribution

Thousand Metric Tons

	Marketing Year	Oil, Peanut		Oil, Cottonseed		Oil, Olive	
		2023/24	2024/25	2023/24	2024/25	2023/24	2024/25
Production							
China	(Oct-Sep)	3,136	3,104	1,164	1,164	9	9
India	(Oct-Sep)	1,123	1,256	1,355	1,311	nr	nr
Turkey	(Nov-Oct)	7	7	193	235	215	410
United States	(Aug-Jul)	96	106	163	131	12	16
European Union	(Oct-Sep)	13	13	24	29	1,549	2,112
Other		1,622	1,822	1,838	1,843	655	786
World Total		5,997	6,308	4,737	4,713	2,440	3,333
Imports							
China	(Oct-Sep)	247	347	0	0	23	40
India	(Oct-Sep)	0	0	0	1	nr	nr
Turkey	(Nov-Oct)	0	0	2	3	53	30
United States	(Aug-Jul)	17	46	1	1	386	445
European Union	(Oct-Sep)	45	47	9	2	230	202
Other		30	33	66	57	414	518
World Total		339	473	78	64	1,106	1,235
Exports							
China	(Oct-Sep)	10	11	6	8	0	0
India	(Oct-Sep)	195	233	1	0	nr	nr
Turkey	(Nov-Oct)	0	0	8	2	106	79
United States	(Aug-Jul)	6	5	10	20	9	8
European Union	(Oct-Sep)	7	6	1	1	686	847
Other		153	330	27	31	368	420
World Total		371	58	53	62	1,169	1,354
Domestic Consumption							
China	(Oct-Sep)	3,373	3,440	1,158	1,156	32	49
India	(Oct-Sep)	1,005	1,010	1,345	1,330	nr	nr
Turkey	(Nov-Oct)	7	7	190	235	185	400
United States	(Aug-Jul)	115	144	152	116	389	453
European Union	(Oct-Sep)	50	54	32	30	1,115	1,395
Other		1,477	1,499	1,847	1,858	762	839
World Total		6,027	6,154	4,724	4,725	2,483	3,136
Ending Stocks							
China	(Oct-Sep)	0	0	0	0	0	0
India	(Oct-Sep)	187	200	46	28	nr	nr
Turkey	(Nov-Oct)	0	0	13	14	99	60
United States	(Aug-Jul)	8	11	20	16	0	0
European Union	(Oct-Sep)	4	4	0	0	182	254
Other		132	158	109	120	140	185
World Total		331	373	188	178	421	499

Foreign Agricultural Service/USDA Global Market Analysis

Table 09: China Oilseeds and Products Supply and Distribution

Thousand Metric Tons

	2021/22	2022/23	2023/24	2024/25
Production				
Oilseed, Peanut	18,308	18,330	19,231	19,000
Oilseed, Rapeseed	15,531	16,317	15,800	15,800
Oilseed, Soybean	16,395	20,284	20,840	20,650
Oilseed, Sunflowerseed	2,154	1,741	1,983	1,750
Other	8,853	10,196	9,069	10,611
Total	61,241	66,868	66,923	67,811
Imports				
Oilseed, Peanut	785	940	774	448
Oilseed, Rapeseed	1,657	5,335	5,486	4,600
Oilseed, Soybean	90,297	104,500	112,000	108,000
Oilseed, Sunflowerseed	157	266	183	132
Other	297	665	690	332
Total	93,193	111,706	119,133	113,512
DomesticConsumption				
Meal, Peanut	4,077	4,005	3,973	3,885
Meal, Rapeseed	11,951	13,512	14,519	14,639
Meal, Soybean	71,100	75,050	77,150	80,850
Other	9,072	10,472	10,678	9,249
Total	96,200	103,039	106,320	108,623
SME				
Meal, Peanut	4,583	4,502	4,466	4,367
Meal, Rapeseed	8,165	9,276	9,992	10,074
Meal, Soybean	70,000	73,900	76,000	79,700
Other	7,760	8,435	8,936	8,147
Total	90,507	96,112	99,394	102,288
Food Use Dom. Cons.				
Oil, Palm	3,300	3,100	2,800	1,800
Oil, Peanut	3,323	3,418	3,373	3,440
Oil, Rapeseed	8,500	8,800	9,700	10,350
Oil, Soybean	17,100	17,900	18,900	20,500
Oil, Sunflowerseed	955	1,803	1,419	717
Other	1,369	1,387	1,369	1,367
Total	34,547	36,408	37,561	38,174
Domestic Consumption				
Oil, Palm	5,100	5,400	5,000	3,300
Oil, Peanut	3,323	3,418	3,373	3,440
Oil, Rapeseed	8,500	8,800	9,700	10,350
Oil, Soybean	17,100	17,900	18,900	20,500
Oil, Sunflowerseed	955	1,803	1,419	717
Other	1,892	2,134	2,051	2,121
Total	36,870	39,455	40,443	40,428
Imports				
Oil, Palm	4,387	6,190	4,377	3,203
Oil, Peanut	166	292	247	347
Oil, Rapeseed	973	1,978	2,039	2,171
Oil, Soybean	291	395	381	296
Oil, Sunflowerseed	513	1,555	1,207	532
Other	798	967	884	956
Total	7,128	11,377	9,135	7,505

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Table 10: India Oilseeds and Products Supply and Distribution

Thousand Metric Tons

	2021/22	2022/23	2023/24	2024/25
Production				
Oilseed, Cottonseed	10,316	11,166	10,783	10,189
Oilseed, Peanut	8,700	6,300	6,000	7,100
Oilseed, Rapeseed	11,100	11,200	11,600	11,520
Oilseed, Soybean	11,889	12,411	11,875	12,582
Oilseed, Sunflowerseed	140	215	112	113
Other	1,021	1,022	1,021	1,021
Total	43,166	42,314	41,391	42,525
Domestic Consumption				
Meal, Cottonseed	4,238	4,443	4,409	4,329
Meal, Rapeseed	4,375	4,350	4,600	4,360
Meal, Soybean	6,273	6,625	7,075	7,000
Other	2,348	2,176	2,069	2,146
Total	17,234	17,594	18,153	17,835
SME				
Meal, Cottonseed	3,434	3,600	3,573	3,508
Meal, Rapeseed	3,113	3,095	3,273	3,102
Meal, Soybean	5,873	6,225	6,625	6,525
Other	2,177	2,021	1,903	2,015
Total	14,597	14,941	15,373	15,150
Food Use Dom. Cons.				
Oil, Cottonseed	1,250	1,315	1,290	1,285
Oil, Palm	7,800	8,300	8,340	8,150
Oil, Peanut	1,185	1,050	995	1,000
Oil, Rapeseed	3,700	3,600	3,900	3,925
Oil, Soybean	5,825	5,400	5,175	6,645
Oil, Sunflowerseed	1,900	2,750	3,525	2,900
Other	375	400	410	395
Total	22,035	22,815	23,635	24,300
Domestic Consumption				
Oil, Cottonseed	1,295	1,361	1,345	1,330
Oil, Palm	8,150	8,900	8,990	8,800
Oil, Peanut	1,195	1,060	1,005	1,010
Oil, Rapeseed	3,780	3,680	3,980	4,005
Oil, Soybean	5,825	5,400	5,175	6,645
Oil, Sunflowerseed	1,900	2,750	3,525	2,900
Other	674	710	730	695
Total	22,819	23,861	24,750	25,385
Imports				
Oil, Cottonseed	4	1	0	1
Oil, Palm	8,004	10,045	8,886	7,786
Oil, Peanut	0	0	0	0
Oil, Rapeseed	34	6	6	26
Oil, Soybean	4,231	3,968	3,308	5,471
Oil, Sunflowerseed	1,956	2,988	3,516	2,905
Other	80	111	131	98
Total	14,309	17,119	15,847	16,287

Foreign Agricultural Service/USDA Global Market Analysis

THE CURRENT STATUS AND KEY CHALLENGES FOR BIOFUEL IN INDIA

Dr. M.K.Mohanty, Professor (BPCL Biofuel Chair) at Odisha University of Agriculture & Technology

India has approximately 500 million tonnes of biomass available per year. Out of which, 120 to 150 million tonnes are in surplus. As a part of the Pro MFG Sustainable Circular Economy Series – Doing Well by Doing Good, powered by BiofuelCircle, Dr. M.K. Mohanty pens down the key challenges and existing state of biofuel in the country.

Biofuels are identified as the primary energy sources obtained in solid, liquid, and gases form from the biomass, and food crops such as sunflower seeds, palm fruit, Jatropha seeds, rapeseed, soybean, etc., which have enormous potential in a developing economy like India. India has approximately 500 million tonnes of biomass available per year, out of which 120 to 150 million tonnes are in surplus.

Further, 12.83% of the total renewable energy generation is contributed by biofuels alone. Moreover, higher conversion efficiencies and lower costs are the significant drivers of bio-energy extraction. The benefits of biofuels are energy security, reduction of import dependency, cleaner environment, Municipality Solid waste (MSW) management, health benefits, and infrastructures investment in rural areas, employment generation and overall additional income to farmers. The liquid biofuels are biodiesel or bioethanol and gaseous biofuel is compressed biogas (CBG) or Bio-CNG.

According to the International Energy Agency (IEA), biofuels have the potential to meet more than a quarter of world demand for transportation fuels by 2050 if favourable policies and investments are in place. At present, biofuels are supported by governments in many different ways, including blending mandates or targets, subsidies, tax exemptions (exemptions from excise and pollution taxes, corporate tax breaks for biofuel producers) and credits, reduced import duties, support for research and development (R&D) and direct involvement in biofuel production, as well as other incentives to encourage local biofuel production and use.

Biofuel Policy in India:

In 2001, India started a modest 5% ethanol blending pilot programme. The biofuel mission was adopted in 2003 with the launch of the National Mission on Biodiesel that sought to achieve 20% biodiesel blending in diesel by 2011–12. This was followed by the National Policy on Biofuel (NPB) in 2009 and subsequently the revised NPB was launched in 2018.

The NPB 2009 envisaged an optional blending target of 20% for both ethanol and biodiesel by 2017 . The objective of NPB 2009 was to facilitate the optimal development of domestic biomass feedstock for biofuel production. The NPB 2009 laid down the vision, goals and strategy for the development of biofuels and proposed an enabling framework of financial, institutional and technological interventions.

The revised policy on biofuels, NPB 2018, became effective from May 16, 2018 and proposed an indicative blending target of 20% ethanol in petrol and 5% biodiesel in diesel by 2030. The objective of NPB 2018 is to reduce crude oil imports, augment farmers' income, generate employment, optimally use drylands and contribute to sustainability. The policy aims to provide financial and fiscal incentives specific to biofuel type, categorized as first generation (1G), second generation (2G) and third generation (3G) fuels.

The first generation category of biofuels includes conventional ethanol and biodiesel. The second generation comprises ethanol from lignocellulosic biomass, non-food crops, industrial wastes and residues streams as well as drop-in fuels from biomass, MSW, plastics and industrial wastes. The third generation includes compressed BioCNG from food wastes, biomass, MSW, sewage water, etc.

The schemes like Sustainable Alternative Towards Affordable Transportation (SATAT) which seeks to establish compressed biogas production units and make CBG available for usage as a green fuel on the market.

Key Challenges in Biofuel Production:

2G Bioethanol Production

At present, there is no policy mechanism incentivising farmers to collect and deliver biomass residues to a next-generation ethanol plant. Therefore, it is important to establish a reliable supply chain for biomass covering collection, transportation and handling of biomass feedstock. If the policy makers seek to foster an industry for a longer term, they could create a mechanism whereby cooperatives or farming communities could be involved in the process of collection, storage and delivery of residues.

In order to reduce supply chain uncertainties and high market risk associated with 2nd -generation biofuel industry, a supply chain should be designed and operated to maximize economical potential and social benefit, and minimize environmental impact. In doing this, India can use its demographic advantage. In cases there are any skill mismatches, they should be addressed through training and integrated within larger national programs like Skill India.

Another key challenge of cellulosic-based bioethanol production is the pre-treatment of the feedstock to make the carbohydrates in the lignocellulose accessible for conversion. Apart from the costs, the key parameter for selection of a pre-treatment method is its efficiency in avoiding degradation of products, which might inhibit subsequent hydrolysis and fermentation. Pre-treatment of raw material represents one-third of the total costs of bioethanol production, thereby influencing the cost of enzymatic hydrolysis and fermentation.

Utilisation of carbon dioxide generated from the plant is also a major concern. Implementation of 2G ethanol plants due to high technological risk, production cost and political/policy risks with low potential returns needs to be addressed for future production.

Biodiesel production

Biodiesel derived from edible oil requires suitable land for cultivation and also challenges food security. Since most of the edible oil in the country is imported, it is not feasible to use edible oil. Numerous agronomical and economic constraints in the cultivation of feedstock like high cultivation cost, low productivity, improper availability of seeds, and unsuitable marketing channels forces cultivators to close their plantation.

On the other hand, production from non-edible oil sources has disadvantages like diminishing performance in cold climates, possible contamination and impurities in animal fats and the lack of a centralized system for collecting such raw materials.

Oil extraction techniques like mechanical extraction of oil requires further filtration and phospholipid removal. Moreover, presses used for mechanical oil extraction are mostly specialized for specific plants and ineffective for a variety of feedstocks. On the other hand, extraction with n-hexane is associated with the risks of negative impact on the environment and human health through the production of sewage and emissions of volatile organic compounds.

Lack of government backing is viewed as a major barrier to the adoption of the biodiesel program. Several steps like implementation of legal actions to encourage use, mandatory biodiesel blending, incentives towards support of the biodiesel program are some of the necessities of the recent time to tackle the challenges.

BioCNG production

Due to poor supply chains and low collection efficiency, there are concerns around feedstock supply and quality. Fluctuations in feedstock availability and quality might impede plant production efficiency, affecting plant profitability in the long term. Decrease in the number of farm animals in rural areas, leading to failure of supply of the committed quantity of waste to plants is one of the reasons for the closure of biogas plants.

Individual household biogas plants require financial investment, which yields only non-monetary benefits, such as biogas which is generally used as cooking fuel. Whereas, large-scale commercial biogas plants managed entirely by private or public-private partnerships aim to generate financial benefits by selling end-products such as electricity, transportation fuel, or heat. The cost of handling and transportation of the waste over long distances is quite high. Competition from organic fertilizer as well as heavily subsidized chemical fertilizers is also a major concern.

Some challenges to biogas production in rural areas includes high up-front installation cost, delays in getting financial support, competition from other fuels, inadequate supply of feedstock, lack of social acceptance and awareness for biogas from substrates like night soil, human excreta, dead animal carcass, lack of proper training and capacity building programmes, awareness regarding its environmental benefits.

Proper segregation, collection, and transportation technologies/strategies are not implemented in cities for MSW, which is one of the primary reasons for the slow growth of the waste-to-energy sector.

Process standardization is difficult due to substantial differences in waste properties across different areas, which impedes the widespread use of biogas technology. Other waste treatment methods, such as composting, vermicomposting, and waste to pellets, which may also be used to treat organic municipal and industrial waste, compete with anaerobic digestion.

Preference for low-cost treatment methods such as composting also acts as restriction, resulting in a lower adoption of biogas digesters for waste management in metropolitan areas. Scrubbing of biogas also requires additional infrastructure which adds to the total cost of the process.

Challenges in third generation biofuels: Algal Biofuel

The challenges and uncertainty involved with algal biofuel production are vast. Economic analysis is a threat, in the form of cost and expenditure. The market acceptability is not certain while they continue to compete with other biomasses.

The utilization of CO2 by algae could lead to uncontrolled pH rise after the conversion to carbonic acid, hence resulting in ionization in the algae production medium. There could be the difficulty of sunlight radiation penetrating the depth of large algae bloom. Hence, the most prominent constraints of algal biofuel production involves factors like:

- Information

  The information regarding interest and research into algae biofuel are still limited. However, more experiments need to be done on how algae biofuel actually performs when used in cars, machinery, airplanes, etc.

- Requirement of high lipid content fuel conversion from algae is broadly based on the feedstock's high concentrations of lipids: fatty, oil-containing acid molecules that can be extracted to create Biofuels.

- Information

  The information regarding interest and research into algae biofuel are still limited. However, more experiments need to be done on how algae biofuel actually performs when used in cars, machinery, airplanes, etc.

- Complicated Process

  Production of algal biofuel takes many steps to become a usable fuel source. This process is complicated and takes time.

- High Fertilizer Use

  Massive quantities of algae can only be grown with the use of more fertilizer. And this fertilizer production requires energy and produces high amounts of carbon dioxide, thus affecting the carbon dioxide neutral status of algae biofuel when considering the whole process.

- Minimizing the algal death from biotic & abiotic factors

  There is a great chance of algal monocultures to be invaded by pests and pathogens, and therefore, crop protection is a major challenge to algal sustainability.

- Large Water Demand

  A high amount of water source is required by the algae in order to avail maximum growth. Sometimes, a high temperature evaporates water level and hampers the growth.

- Expensive to Produce

  The cost of algal biofuel production is still much higher than fossil fuels till date.

- Quality Issues

  here are several species of algae present in the earth crust but all of them don't produce the same amount of oil.

- Land Use

  Regardless of the growth strategy employed and efficiency of oil extraction, the scale of implementation that is required to replace a meaningful amount of fossil fuel is significant.

- Nutrient Challenge

  Algae need light, nutrients, water and a carbon source, most often CO2, for efficient growth. The major nutrients required by most algae include nitrogen, iron, phosphorous and sulphur.

The Inference

In India, the significance of building a robust biofuel sector to address the issues of energy security and fuel self-sufficiency has been widely recognised. Despite the fact that the food vs fuel issue is highly significant on a global scale, it is essentially irrelevant to India's biofuel production programme due to the country's deliberate choice to not employ any edible feedstock for bio-energy production, which also acts as a constraint.

The National Biofuel Policy was created to capitalize on the numerous environmental, social, and economic advantages that would result from the country's large-scale biofuel production. Significant barriers in biofuel production are identified as lack of governmental support for sustainable supply chain standards and solutions, lack of entrepreneurship support, lack of subsidies/ incentives for creating competition among bioenergy producers.

New policies and strategies or modifications in the existing strategies may help in eliminating some of the barriers mentioned above. In order to boost the biofuel industry in India, the need for popularisation of biofuel usage by blending with conventional fuel should be made mandatory along with subsidized rates.

While favourable government policies and active involvement from the local community and private enterprises can keep the programme running in the short term, it is critical to have a solid long-term strategy in place. Given the existing feedstock options, technological state, and regulatory options, the current trajectory is unlikely to be adequate in the long run.

A significant research effort on the development of second and third generation feedstock is required to meet the country's future bio-energy demands.

HEALTH NEWS

Piggy Sooy: Moolec Gains USDA Approval for Pork Proteins Grown in Soybeans

Luxembourg-based Moolec Science, which uses molecular farming to grow animal proteins in plants, has earned clearance from the US Department of Agriculture for Piggy Sooy, which are soybeans containing pork proteins.

Moolec has received approval from the USDA for its 'plant-grown' meat proteins, with the government body stating that its genetically engineered soybeans are unlikely to pose an increased risk of pests compared to non-modified soybeans.

In its regulatory review, the USDA's Animal and Plant Health Inspection Service (APHIS) didn't find "any plausible pathway" by which Moolec's Piggy Sooy brings a higher pest risk. This means it isn't subject to the APHIS regulation that governs the movement of genetically modified organisms.

The regulatory clearance will enable the company to plant and transport Piggy Sooy soybeans without needing any permits, as is the case with non-modified ingredients, according to co-founder and CEO Gastón Paladini.

"We believe this milestone sets the stage for a revolution in the food-industrial biotech landscape, paving the way for expedited adoption of molecular farming technology by other industry players," said co-founder and CTO Martin Salinas. "This compelling advancement signifies a stride in enhancing our operational efficiency, transforming our methods of raw material sourcing, and optimising our downstream crushing and processing operations."

Patented tech produces pink pork soybeans

Moolec had announced the development of Piggy Sooy in June last year, as part of its Meat Replacement Program. The company is bioengineering soybeans to produce porcine myoglobin, using the plants as the 'bioreactors' themselves. Its seeds have achieved a high expression of pig proteins (up to 26.6% of the total soluble proteins), surpassing initial projections by fourfold.

The tech has been patented – which will aid its regulatory pathways – and produced beans that have a pink hue like pork. "This achievement opens up a precedent for the entire scientific community that is looking to achieve high levels of protein expression in seeds via molecular farming," Amit Dhingra, Moolec's chief science officer, said at the time.

Since then, the Nasdaq-listed company has raised \$30M to fund R&D and scale-up efforts, which involved both equity, and cash and in-kind contributions, including access to the soybean inventories of Grupo Insud. Prior to this, Moolec had inked a deal with Bioceres, the Argentinian agtech firm it spun off from as a seed startup, to secure the supply of 15,000 tonnes of soybeans.

The USDA APHIS approval allows the startup to accelerate its go-to-market strategy. Moolec plans to provide food manufacturers with the functional, nutritious and eco-friendly ingredients for use in their product formulations – this involves replacing meat in sausages, burgers and the like.

Paladini remains tight-lipped about the companies Moolec is working with, but it has been in talks with ingredient processors for partnerships that could see the startup license its IP, or work with them in downstream processing to recover and commercialise the proteins using their networks. The Luxembourg-based company also has its own industrial facility in Argentina, which can crush 10,000 tonnes of soybeans annually and help it commercialise.

Molecular farming has been recognised as a more affordable and easily scalable option than cell cultivation or precision fermentation. "We are unlocking the power of plants by leveraging science to overcome climate change and global food security concerns," Paladini outlined. Competitors like Alpine Bio (formerly Nobell Foods), Mozza, PoLoPo and IngredientWerks, Finally Foods and Miruku are all vying to get a slice of a market tipped to reach $3.5B before the end of the decade.

Moolec to launch GLA-rich oil in 2025

Courtesy: Moolec

While the APHIS clearance is welcome news for its meat proteins, the Piggy Soybeans won't be its first product to go to market. That honour lies with GLASO, a nutritional oil rich in GLA (an omega-6 fatty acid), which has already received the USDA's nod and is set to come to market in 2025.

This oil is produced through a strain of safflower using a patented tech called SPC, with the same strain also helping Moolec produce a bovine chymosin protein, which is used in cheese and has also received the greenlight by APHIS. After GLASO, it will release YEAA1, an iron supplement and meat ingredient derived from yeast, and Piggy Sooy. Besides these, the company is also growing bovine myoglobin (a beef protein) in yellow peas.

But while the APHIS approval means its pork soybeans don't pose an increased risk of pests, authorisation from other agencies – chiefly the Food and Drug Administration – will be key for commercialisation. Moolec is already in the consultation process with the food safety body, and while Paladini declined to comment on a timeline, he confirmed that "everything is on track".

Moolec's announcement sent its stock soaring, which was up by 121% on Monday. But when you look at long-term trends, the company's shares have gone down from a record high of nearly $20 to under $2.50 – before this week's announcement, it was at $1.40. Paladini ascribes this to "a mismatch between market understanding and the real opportunity", adding that the company needed better exposure to fully explain its story.

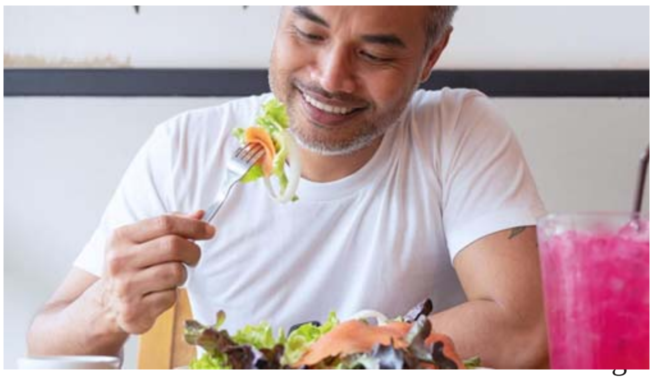
The startup plans to sell its soy and pea proteins with the meat proteins embedded in the matrix, instead of extracting and purifying the latter. It's doing so to "save purification costs and focus on affordability", Paladini said. "Meat producers need both proteins (soy and pig) in their processed meat products," he added.

It would help Moolec disrupt not just the alternative protein market, but the conventional sector too, joining a host of companies taking the blended meat approach. These products can potentially help consumers eat less meat, making their diets more climate-friendly as a result, and increasing the credence of plant proteins. Only recently, US meat purveyor Pat LaFrieda rolled out a 50Cut Burger using Mush Foods' mycelium-beef blend, while Australia's Harvest B ventured into the category with blended beef and lamb products, and New York

City's Björk Cafe & Bistro introduced a 50-50 Meatloaf that combined its beef mince with Havredals' fava bean grounds.

Source: Green Queen

Everything You Need to Know About Omega-5s



your omega-3s in. But did you know that your salmon steak is also loaded with omega-5s?

Omega-5s? There are *more* omegas? Yep—and if you've never heard of them before, you're not alone.

"While omega-5 fatty acids provide many similar health benefits as omega-3 fatty acids, we tend to hear less about them because they are more difficult to get from foods or through our diet," says Rima Kleiner, a dietitian based in McLean, Virginia.

If you look closely, you might even find an omega-5 supplements in the vitamin aisle in your grocery store. Keep reading to learn all about omega-5s, its health benefits, and supplementation considerations.

What are omega-5s?

Like omega-3s, omega-5s are fatty acids. "Also known as punicic acid, omega-5 is a long chain polyunsaturated fatty acid found in certain seed oils like pomegranates," says Michelle Routhenstein, R.D., a preventive cardiology dietitian based in New York City. Fatty acids help carry out several functions of the body, including influence cell and tissue metabolism, regulate hormone responses, and assist in cognitive function.

Jena Brown, R.D., of Victorem Performance Nutrition in Brenham, Texas, further explains that that this type of polyunsaturated fatty acid is a conjugated linolenic acid with three double bonds beginning at the fifth position from the methyl (or omega) end of the fatty acid.

What are the health benefits of omega-5s?

So far, the research on this nutrient has been preliminary looking at its effect on inflammation and cancer prevention, but there's a big caveat: Most studies are conducted in mice, so you can't exactly extrapolate conclusive benefits to humans, Routhenstein says.

That said, early findings are promising that omega-5s have similar health benefits to that of omega-3s, including anti-inflammatory and antioxidant properties, says Kleiner. Some of the health benefits of omega-5s include lowering inflammation that causes chronic diseases (like heart disease, type 2 diabetes and certain cancers), supporting brain and skin health, and improving HDL cholesterol and insulin sensitivity. Again, the majority of these studies on diet-induced obesity and insulin resistance are animal studies.

Omega-5's has gained some attention for their therapeutic potential. They've been more recently researched for their effects on cognitive and brain health, including its use in preventing certain neurological disorders.

"Neurodegenerative diseases affect millions of people worldwide. Punicic acid's anti-oxidative and anti-inflammatory effects are being explored for the prevention and treatment of neurodegenerative diseases, however, there are challenges to overcome before its use for therapeutic use, such as the body's slow ability to absorb and use it," Brown says.

What are food sources of omega-5s?

We likely hear less about omega-5 fatty acids is because they are more difficult to obtain from your diet than omega-3 fatty acids. "We can get omega-3s from several foods—particularly fatty fish like salmon, tuna and sardines, shellfish like lobster, scallops and oyster and some plant foods like walnuts and flaxseed," Kleiner says.

There are only a few known foods that contain omega-5 fatty acids, though. They include:

salmon

coconut oil

pomegranates and pomegranate seed oil

You can probably skip fixating over getting certain amounts of omega-3s, omega-5s, and omega-6s in your diet, though, Kleiner says. Just work on maintaining a balanced, healthy diet where you eat foods in all colors of the rainbow.

"While it is important to understand that these polyunsaturated fats like omega-3s and omega-5s are essential and provide many health benefits, try not to get too focused on consuming specific nutrients," says Kleiner. Instead, she encourages focusing on consuming a variety of nourishing and nutrient-rich foods rich in protein, fiber, and heart-healthy fats.

Should I take an omega-5 supplement?

No surprises here: omega-5 supplements are typically made from pomegranate seed oil. So much so that the word 'pomegranate' may even be part of the product's title. "Omega-5 supplements are often combined with polyphenol extracts from pomegranates or other blends," says Brown.

Since the health benefits of omega-5s haven't been proven, you can probably save your money on these products. If you're itching to try it, you should always consult with your doctor or dietitian before taking a new supplement. "An optimal dosage for health benefits has not been established, and more research is needed for safety and effectiveness," says Brown.

What are the risks of taking an omega-5 supplement?

Just to make it clear: "Caution should be taken in recommending omega-5 supplementation, as the preliminary findings are found in rats and mice, and not human trials," says Routhenstein. Thus, we don't have definitive findings on its effects—which could pose potential harm, especially in those with certain medical conditions or taking certain medications.

Bottom line: Skip buying the pomegranate oil supplement and save the cash until science says otherwise.

Source: AOL

FDA proposes nutritional information on the front of food packages.

Packaged foods often come with a number of health claims, which can make it confusing for people to know what's good or bad for them.

The Food and Drug Administration on Tuesday proposed a new rule for nutrition labels on packaged food and drinks that's intended to help people make healthier choices at a glance.

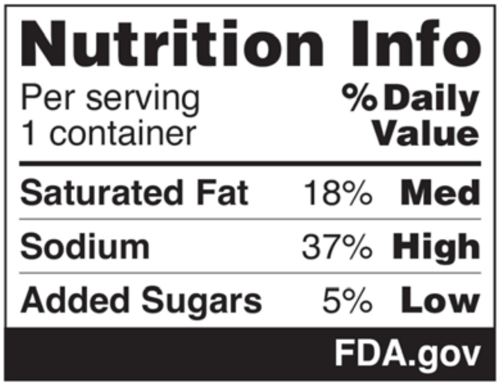
Under the proposed rule, which shoppers could see as early as 2028, food manufacturers would be required to display levels of saturated fat, sodium and added sugar on the front of the packaging, in addition to the standard nutrition labels on the back.

Packaged foods in the United States often come with a number of health and nutrition claims, which can make it confusing for consumers to know what's good or bad for them, said Lindsey Smith Taillie, a nutrition epidemiologist at the University of North Carolina Gillings School of Global Public Health.

Fruit drinks, for example, may advertise high levels of vitamin C on the front of the bottle, making them seem like a healthy choice, but at the same time, they are loaded with added sugar, Smith Taillie said.

The idea is that by placing certain nutrition information directly in front of consumers, they'll be more likely to make health-conscious decisions.

"We believe that food should be a vehicle for wellness, not a contributor of chronic disease," Rebecca Buckner, the FDA's associate deputy director for human food policy, said on a call with reporters.



The proposed front-of-package labels would include saturated fat, sodium and added sugar, along with whether products contain high, medium or low amounts of the nutrients.U.S. Food & Drug Administration

The FDA's proposed front-of-package label would include the amount of saturated fat, sodium and added sugars and whether those amounts are considered "low," "medium" or "high."

FDA officials said the label it landed on was backed by science, including a body of research, consumer focus groups and an agency-led study of nearly 10,000 adults that looked at how people responded to several possible designs.

Saturated fat, sodium and added sugar were chosen as the three nutrients because research shows they're leading contributors to chronic disease, including cancer, heart disease and diabetes, Buckner said.

"I think people want to know this information to help them make good decisions," said Dr. Yian Gu, a nutrition epidemiologist at the Columbia University Medical Center in New York City.

The extra information won't do much good if people aren't aware of how certain nutrients, such as saturated fat, can affect their health, Gu said, adding that more work needs to be done on educating people about their nutrition.

The FDA proposed the labels amid high rates of diet-related chronic diseases, such as Type 2 diabetes and heart disease, in the United States. Heart disease is the leading cause of death in the United States, accounting for 1 in every 5 deaths, according to the Centers for Disease Control and Prevention. About 1 in 10 people have diabetes, mostly Type 2 diabetes. And about 2 in 5 adults have obesity, the CDC says.

"These diseases are not coming from nowhere," Gu said. "If people are not aware of the science behind all of this nutrition, they will not pay attention to it."

The front-of-package labels wouldn't go into effect immediately, according to the FDA. The proposal includes a 120-day comment period, after which the agency may make additional changes to the proposal or finalize the new rule.

Large food manufacturers would have three years after the rule is finalized to make the changes to most of their products, the agency said. Smaller manufacturers would get an additional year to implement the changes.

While it's not the FDA's intention, Buckner said the new food labels could lead food manufactures to reformulate their products so they could move to the "low" or "medium" categories.

The Consumer Brands Association, an industry trade group, has opposed the mandatory labeling, saying the FDA is considering "schemes with arbitrary scales and symbols that could cause confusion among consumers."

Sarah Gallo, senior vice president of product policy at the Consumer Brands Association, said in a statement that the group has instead pushed the FDA to collaborate on industry-led initiatives, including Facts Up Front, which allows food manufacturers to voluntarily summarize important nutrition information — such as calories, saturated fat, sodium and added sugars — on the front of packaging. The industry has also introduced SmartLabel, which allows consumers to access detailed nutritional information via QR codes, Gallo said.

Will the labels affect consumers' habits?

Putting nutrition labels on the front of packages isn't a new concept — at least outside of the United States. Dozens of countries, including the United Kingdom, Mexico, Chile, Australia and New Zealand, have implemented similar measures.

Since 2016, packaged foods in Chile had black, hexagonal labels on the front stating whether the products were high in calories, saturated fat and sugar.

In 2016, Chile introduced mandatory labels on the front of packaging, alerting consumers to high levels of sugar, saturated fat and other potentially harmful ingredients.

In 2022, Brazil also implemented mandatory front-of-package labels for products.

Colleen Tewksbury, an assistant professor of nutrition science at the University of Pennsylvania, said research has found that the labels do influence what people buy in those countries.

However, she said, the findings may not easily translate to the United States, where "individualism" prevails and consumers don't "want to be told what to do."

Often, she said, the people who change their buying behaviors were the ones who were already looking to make changes.

"Research is relatively clear that having very simplistic front of packaging labeling does catch people's attention, but the second step to that is whether or not it changes purchasing behaviors," Tewksbury said. "We really don't know if it's going to fully impact people's purchasing habits."

Smith Taillie, of the University of North Carolina, questioned whether the new label would help people make healthier choices, noting that the design looks similar to what's already found on the back of food packaging.

She also said the front-of-package label could cause confusion among shoppers by including daily value percentages and a low-to-high ranking system.

"A 'low' in sugar label on a product that does not typically contain sugar anyway may lead consumers to think a product is healthier than it is," she said.

What's more, she added, items that come in small portion sizes — like salty potato chips — are unlikely to get the "high" designation, also giving people a false impression about their healthiness.

SOURCE: FDA

Black Soldier Fly Oil: Production, Benefits, and Applications

Introduction

Black Soldier Fly oil provides significant nutritional benefits for many animal species while offering a sustainable alternative to increasingly limited conventional resources. Its diverse uses and unique properties make it a promising ingredient across multiple sectors.

What Is Black Soldier Fly Oil?

Black Soldier Fly oil is derived from the larvae of the Black Soldier Fly (*Hermetia illucens*), an insect native to South America but now found worldwide. These larvae can transform large amounts of organic matter into valuable nutrients, being particularly rich in protein and fat. The extracted oil is especially noteworthy for its high content of essential fatty acids, vital for the balanced nutrition of many animal species. Initially used in animal feed, it is now seen as a sustainable alternative to traditional oils (e.g., fish oil or certain vegetable oils) whose production puts increasing pressure on the environment.

The Production Process

The production of Black Soldier Fly oil begins with rearing larvae on organic substrates (agricultural by-products, residues from the food industry, etc.). This step exemplifies circular economy principles by converting waste materials into valuable proteins and fats. Once the larvae reach maturity, they are harvested and processed. Various methods (pressing, grinding, drying) are used to separate the protein (insect meal) from the oil (insect oil), ensuring that key nutrients remain intact. The resulting oil is highly versatile: it can be used in animal feed, cosmetics, or even biofuel production.

Nutritional Benefits and Applications in Animal Feed

Primarily used in animal feed (aquaculture, poultry, pig farming, and pet food), Black Soldier Fly oil is notable for its essential fatty acid profile. It contains a substantial proportion of lauric acid (around one-third), known for its antimicrobial properties and positive effects on the gut microbiome and digestion.For chickens, for example, lauric acid is not naturally synthesized. Incorporating Black Soldier Fly oil into their diet thus offers a significant health advantage.

Comparison with Other Traditional Oils

- Fish oil: while rich in omega-3 fatty acids, it faces growing concerns due to overfishing and resource depletion.
- Vegetable oils (palm, soybean, rapeseed, sunflower, etc.): their production is often concentrated in a limited number of countries, making supply chains vulnerable to disruptions and price hikes.

By contrast, Black Soldier Fly oil can be produced locally in most regions. Its growing industrialization also makes it increasingly competitive from both an economic and environmental standpoint. Nutritionally, it stands out for its fatty acid profile (lauric acid, palmitic acid, and linoleic acid), opening up new possibilities for enriched animal feed formulations.

Other Applications of Black Soldier Fly Oil

- Cosmetics and Skincare: Its beneficial fatty acids make it an appealing natural ingredient for creams and moisturizers.
- Pharmaceutical Industry: Its antimicrobial properties, low environmental impact, and potential benefits for immune and digestive health are drawing attention.
- Biopolymers and Bioplastics: It can serve as a promising raw material for producing more sustainable materials.
- Biofuels and Biodiesel: It has the potential to replace traditional fossil fuels, helping to reduce carbon footprints.

Conclusion

Black Soldier Fly oil is more than just an animal feed ingredient: it is a sustainable, nutrient-rich solution that can lower environmental impact while improving animal health. As industries seek more eco-friendly practices, Black Soldier Fly oil emerges as a promising alternative to traditional oils, fitting neatly into circular economy initiatives. Whether you're aiming to enhance animal health or reduce your environmental footprint, this oil stands out as a high-potential innovation.

Source: Compagnie des Insectes

GERANIUM ESSENTIAL OIL

Introduction

Rose scented geranium (Pelargonium graveolens L.) of genus Pelargonium L. Herit, belonging to family Geraniaceae, is one of the economically important aromatic plants from which highly prized geranium essential oil for the trade is extracted for flavour and fragrance industry. Geranium oil is highly valuable for its profound and strong rose like odour. Leaves of rose scented geranium are densely pubescent and are highly aromatic in nature. The colour of geranium oil is slightly yellowish with pleasant odour, insoluble in water and soluble in alcohol.

Essential oil of geranium contains two types of constituents i.e. alcohol and esters. The marker components are citronellol, and geraniol. Geranium essential oil is parallel to rose oil owing to some identical constituents. Geranium essential oil is basically used in industries in particular in perfumery, beauty and aromatherapy industries all around the world. It is one of the quality skin care oils as it is used for opening skin pores and cleansing complexions. Other additional common uses of geranium essential oil are in infectious disease treatment, haemorrhoids, inflammation, serious amenorrhea and even cancer. In the French medical profession, it is used in the treatment of polygenic disease, diarrhoea, vesica issues, internal organ ulcers, jaundice, liver issues, sterility and urinary stones. Leaves are also utilized as herb drinks to fight anxiety and relieve strain.

Botanical Name: *Pelargonium graveolens L.of genus Pelargonium L. Herit*

Geranium Harvest

At each cutting, if this is done manually, the entire canopy is removed with the exception of one

complete branch which is left to continue to supply nutrients to the plant. When sufficient new leaf growth has been made to support the plant's growth, the remaining branch is cut. With mechanised forage harvesting, the complete canopy is cut, and care must be taken that the cutting height is not set too low, or regrowth will be slow, and the plants may die.

The crop is effectively a long term perennial and can remain in the field for 10 or more years. Commercial life will depend on the health and vigour of the stand and the rotation requirements of the farm. 3 to 5 years may prove to be an economic and practical crop life.

Optimal Timing: Plants are harvested when they reach maximum biomass, ideally just before or during peak bloom.

Method: Aerial parts (leaves and stems) are cut, typically by hand or mechanical harvesters.

Pre-Processing: Harvested material is often left to wilt or semi-dry for several hours to a day to increase oil concentration and reduce moisture before distillation. The cut material should be distilled the same day as it is cut. Distillation is by wet steam. Oil yields should be in the range of 60-70 kg/ha/year.

Production and Extraction

Method: The primary method is a steam distillation which passes steam through the leaves to release oil. Steam distillation is a specialized separation process used to isolate temperature-sensitive compounds, such as essential oils and aromatics, by passing steam through the material. By creating a mixture of immiscible liquids (water and oil), the system boils at a lower temperature than the components' individual boiling points, preventing thermal decomposition.

Yield: Approximately 500 kg of leaf material yields around 1 kg of concrete (concrete is about 0.2% yield).

Advanced Techniques: Other methods like supercritical fluid extraction, microwave-assisted extraction, and solvent extraction are used for higher quality or yield, with supercritical extraction yielding up to 2.53% under optimized conditions.

Global Production

Top Producers: Egypt is the leading producer (200-230 tonnes), followed by China (50 - 80 tonnes), and Madagascar (5 tonnes).

Industry Demand: Strong demand exists for natural, high-quality aromatic oils in pharmaceuticals and cosmetics.

Geranium cultivation is considered a sustainable and profitable agricultural initiative for farmers, offering high-income potential while supporting crop diversification.

Composition of Geranium Oil: Geranium oil is complex in composition, and differs (is characteristic) by origin. The primary characteristics of the two major sources on the market, Egyptian and Chinese are:

Major Constituents : Chinese type / Egyptian type

Citronellol 32-43% / 25-36%

Geraniol 5-12% / 10-18%

6,9-Guaiadiene 3-7% up to 0.5%

10-Epi-ã-Eudesmol and Others 3-6%

Key Benefits

Skin Care: Known for balancing sebum, treating acne, eczema, and dermatitis due to its antimicrobial and anti-inflammatory properties.

Aromatherapy: Used to alleviate anxiety, uplift mood, and promote relaxation.

Natural Repellent: Acts as an effective, natural insecticide.

Health Benefits: Contains compounds such as citronellol and geraniol that provide antioxidant and anti-inflammatory benefits.

LAUGH AND LOUD

Q. I asked the guy sitting next to me if he had any Sodium Hypobromite…

A. He said NaBrO

****

Q: Why was the mole of oxygen molecules excited when he walked out of the singles bar

A: He got Avogadro's number?

****

Q. As an ion chromatography chemist I made this one up:

A. Anions aren't negative, they're just misunder stood.

****

Q: What emotional disorder does a gas chromatograph suffer from?

A: Separation anxiety.

****

Q: What did one titration say to the other?

A: "Let's meet at the endpoint."

Copper -Cu, and Tellurium (Te) makes a real CUTE couple.

****

Q. Why was Searc Crow get a Nobel Prize ?

A. He was outstanding in his field.

****

Q. Did you know about the Scientists who had TWINS?

A. They name them ALISON and CONTROL

****

Q. Tired of Signal REDLIGHT ?

A. Travel at 114,004,827 mph. This velocity will BLUESHIFT them enough to appear GREEN.

****

Q. How do you tell if someone is a CHEMIST or PLUMBER ?

A. See, how they pronounced UNIONIZED.

****

1. You will meet a woman who wants to know all about you.
2. Really, where will we meet?
1. At a Biology lab.

****

Q. Why did the Acidic water get a GYM Membership?

A. It wanted to be a Buffer Solution.

MEMBERS' PAGE

WHY COCOA HOLDS SECRET TO KEEP YOUR BODY YOUNG

by R.C. ARORA (Ex. Manager Q.C. - S.F.F.I., New Delhi)

New study by UK scientists suggests that a natural plant compound called theobromine, which is abundant in cocoa, can potentially slow down cellular ageing.

Theobromine is the primary alkaloid found in the Theobroma (that's Greek for food of the gods) cacao plant. Apart from polyphenols, that's what makes cocoa taste bitter. Theobromine is also found in tea and coffee, though in lesser amounts.

Published in the journal Aging, the study by King's College, London researchers compared theobromine levels in blood of people (average age 60) in two European cohorts. Blood- based biological ageing makers were used to analyse their DNA. These markers were based on patterns of "bookmarks" on our DNA , called methylation, that change over the course of our lives. The research found that those with higher theobromine in their blood had a biological age lower than their actual age.

Which chocolates have more of theobromine ?

- Cocoa powder, 2634 mg*
- Unsweetened baking chocolate, 1297
- Dark chocolate (70-85% cocoa), 802
- Dark chocolate (60-69% cocoa), 632
- Dark chocolate (45-59%), 493
- Hot cocoa, 68

*all measures per 100 gm.

300-600mg is safe to consume daily. It's impossible for humans to consume toxic amounts from commercial chocolates.

According to Jordana Bell, Study Author and Professor, King's College, London; Theobromine might be affecting gene activity that contributes to aging and health. While we're not saying people should eat more dark chocolate, this research can help us understand how everyday foods may hold clues to healthier, longer lives.

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