

REVIEW: VEGETABLE OIL AND BUTTERS, THEIR ANTICELLULITIC EFFECT, COMPOSITION, MECHANISM OF ACTION AND CLINICAL TRAILS

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Abstract. *Fibro-sclerotic edematous panniculopathy is a condition that affects 80% of post-pubertal women. The symptomatology represents a degenerative alteration of the dermal and hypodermic tissue, unaesthetic, for both women and men. For this reason, new treatments and new anti-cellulite cosmetic actives are constantly being researched.*

Phytocosmetology has made available natural substances that act against dermo-hypodermic dystrophy in different ways: reducing non-inflammatory edema, reducing lipid deposits and blocking the glycation of collagen fibers.

Vegetable oils and butters are important functional agents in the formulation of cosmetic products, but they can also play an essential role as cosmetic actives.

Until now, a systematization of vegetable oils and butters as cosmetic actives with an anti-cellulite role has not been done.

The objective of this review is to highlight and list in a single work, the cosmetic assets such as oils and butters with an anti-cellulite role, analyzing the chemical composition, the anti-cellulite action mechanisms and the clinical studies existing to date regarding their anti-cellulite effect.

Keywords: cellulite, lipolysis, anti-edematous, oils and vegetable butters, collagen former

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1.Introduction

Edema fibro-sclerotic panniculopathy represents a dermo-hypodermic dystrophy, also popularly called "cellulite". In the scientific literature, we find it under the name of liposcerosis, dermo-hypodermic- edematous-fibrosclerosis or dermopaniculitis.

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Physiologically and anatomically, it represents an excessive accumulation of fat cells at the adipocyte level, with insinuation of the fat lobes into the dermis, reduction in vertical connecting tissue, and thinning of the dermis layer with aging. The main cause of thinning of the dermis is caused by the loss of hyaluronic acid from the extracellular matrix of the connective tissue.

Histological changes that occur in liposclerosis are: interstitial edema, hypodermic fatty nodules insinuated in the dermis, maldistribution of blood capillaries and glycation of the collagen. Depending on these histological changes, dermatologists classify cellulite into 4 grades: Grade I (Edematous cellulite), Grade II (Adipose cellulite) Grade III (Fibrous cellulite) with micronodules and Grade IV (Sclerotic cellulite) with macro nodules.

The determining and favoring causes of the appearance of cellulite are given by the specific architecture of the hypodermis of women, hydro saline retention accentuated by the premenstrual syndrome with non-inflammatory edema (buttocks, thighs) caused by estrogen-progestative secretion, microvascular alterations with venous stasis that accentuate the non-inflammatory edema together with the maldistribution of arterial capillaries with the appearance of non-vascularized areas, obesity, sedentary lifestyle, hypertrophy of subcutaneous fatty tissue due to the caloric surplus, aging because of the glycation of collagen fibers and because of the loss of glycosaminoglycans in the dermis layer.[1]

Nowadays, clinical evaluation of cellulite can be done by different methods, some of them frequently used by dermatologists and others used only in clinical trials. Among these we mention biopsy, clinical photographic evaluation, ultrasound, optical imaging, magnetic resonance imaging, vascular imaging, thermography, capillaroscopy, lymphoscintigraphy, micro dialysis, measurement of skin laxity, measurement of body fat by plyometrics, measurement of lipolysis by assessment of glycerol clearance.[2]

The treatment of dermo-hypodermic dystrophy has the following objectives:

1. Reduction of non-inflammatory edema by stimulating lymphatic and venous drainage with draining substances (ivy extract, wild chestnut extract, fucus powder) and capillarotonic actives (*Ruscus aculeatus* extract).

2. Reducing lipid deposits by stimulating lipolysis and inhibiting lipogenesis through lipo-reducing substances (caffeine, carnitine, theophylline, theobromine) and reducing caloric surplus.

3. Inhibiting the glycation of collagen by antiglycation agents (hesperidin and antioxidant agents).

4. Barrier skin repair agents, emollients, which improve skin appearance.

The lipolytic mechanisms found in the scientific literature involve the activation or inhibition of neuroreceptors (alpha, beta, neuropeptide Y), increasing AMPc by inhibiting phosphodiesterase or insulin, increasing spermidine/spermine-N1-acetyltransferase (SSAT) levels, increasing adiponectin, aquaglycerolporin-7

proteins and PPARs Y1 Y3 (peroxisome proliferator activated receptor). [1] [3] [4] [5] [6]

2. Material and methods

The role of natural oils/butters in cosmetic formulations.

Vegetable oils have in their composition a saponifiable part (triglycerides, monoglycerides, diglycerides of saturated and unsaturated fatty acids), about 1% unsaponifiable part (tocopherols, carotenoids, triterpenoid alcohols, phytosterols, flavonoids, ferulic acid, oryzanol, waxes, phospholipids), saturated and unsaturated fatty acids. According to scientific literature, vegetable oils in cosmetic formulations act as carrier oils, penetration agents, barrier lipid repair agents, reduction of TEWL agents (Transepidermal water loss) and other beneficial effects given by the unsaponifiable part of their composition. [7] [8] [9] [10].

2.1. The role of natural oils/butters in anti-cellulite cosmetic formulations.

Vegetable oils have the role of acting against fibrous cellulite by inhibiting the glycation of collagen in the dermis (due to the antioxidants in their composition) and by repairing and nourishing the skin. The most used vegetable oils used in anticellulite cosmetic formulations, existing on the market until now (it was studied 64 cosmetic products found in Douglas and Sephora stores), are reported in Table 1.

Table 1. Vegetable oils found in anticellulite cosmetic products on the market.

| | |
|--------------------------------------------|-------------------------------------------------------------|
| Prunus Armeniaca Kernel Oil | Theobroma Cacao Seed Butter |
| Simmondsia Chinensis Seed Oil (Jojoba oil) | Argania Spinosa Kernel Oil (Argan oil) |
| Triticum Vulgare Germ Oil (Wheat Germ Oil) | Persea Gratissima Oil (Avocado Oil) |
| Cannabis Sativa Seed Oil (Hemp Oil) | Hippophae Rhamnoides Seed Extract (Sea Buckthorn Oil) |
| Prunus Amygdalus Dulcis Oil (Almond Oil) | Butyrospermum Parkii Butter (Shea butter) |
| Helianthus Annuus Seed Oil (Sunflower Oil) | Macadamia Integrifolia/Tetraphylla Seed Oil (Macadamia Oil) |
| Vitis Vinifera Seed Oil (Grape Oil) | Glycine Soja Oil (Soybean Oil) |
| Oryza Sativa Bran Oil (Rice oil) | Carthamus Tinctorius Seed Oil (Safflower oil) |

European distributors of natural cosmetic ingredients present the following anticellulite vegetable oils in their product information file. (Table 2.)

Table 2. Vegetable oils marketed by European distributors as having an anticellulitic effect.

| |
|-------------------------------------------------------------------------------------------------------|
| Helianthus Annuus Seed Oil, Bellis Perennis Flower Extract (Daisy Oil) |
| Caprylic/Capric Triglyceride, Hydrogenated Vegetable Oil, Coffea Arabica Seed Extract (Coffee Butter) |
| Carapa Guianensis Oil (Andiroba Oil) |
| Corylus Avellana Seed Oil (Hazelnut Oil) |
| Taraktogenos Kurzii Seed Oil (Chaulmoogra Oil) |
| Carapa procera seed oil (Touloucouna Oil) |

This review will search the scientific literature and will analyse if there is a scientific data that will support their anticellulitic claim.

2.2. Natural oils/butters with clinically proven anticellulite effect.

To obtain a scientific classification of vegetable oils and their anticellulite role and mechanism, we will search in two different scientific databases, PubMed and Google Scholar. Overall, 1000 clinical studies were analyzed, and those that did not contain natural vegetable oils in their anticellulite formulations, were eliminated. Only clinical studies that contained anticellulite formulations with vegetable oils or scientific articles with anticellulite vegetable oils were taken into account. Twenty clinical trials were considered to meet the selection criteria. (Fig.1)

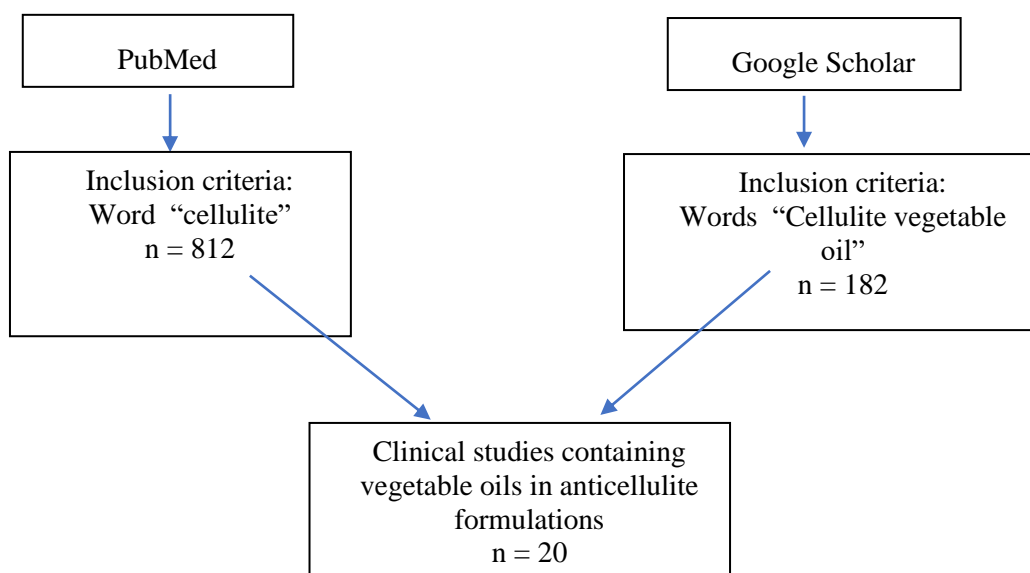


Fig. 1. Flowchart with method of selection of scientific publications.

The selected studies were analyzed after the type of oil and its role in the study or in the formulation. (Table 3)

Table 3. Clinical studies with anticellulite formulations that contain vegetable oils.

| Vegetable Oil | Clinical Study | Role |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Vitis Vinifera Seed Oil (Grape Seed Oil) | <i>Parallel placebo-controlled clinical study of a mixture of herbs sold as a remedy for cellulite</i> , M Lis-Balchin | Anticellulitic effect, in synergy with other oils |
| Oenothera Biennis Oil (Evening Primrose Oil) | | |
| Glycine Soja Oil (Soybean Oil) | <i>Efficacy of Slimming Cream Containing 3.5% Water-Soluble Caffeine and Xanthenes for the Treatment of Cellulite: Clinical Study and Literature Review</i> , Sang-Young Byun, Soon-Hyo Kwon, Su-Hak Heo, Jae-Seong Shim, Mi-Hee Du, Jung-Im Na | Carrier oil |
| Centella asiatica oil extract | <i>Centella asiatica in cosmetology</i> , Wiesława Bylka, Paulina Znajdek-Awizeń, Elżbieta Studzińska-Sroka, and Małgorzata Brzezińska | Lipolytic, Activates microcirculation (asiaticozids) Stimulates collagen synthesis |
| Centella asiatica oil extract | <i>Efficacy of an Anti-Cellulite Herbal Emgel: A Randomized Clinical Trial</i> , Ngamrayu Ngamdokmai, Neti Waranuch, Krongkarn Chootip, Katechan | Lipolytic, Activates microcirculation (asiaticozids) Stimulates collagen synthesis |
| Coffea Arabica Seed Extract | Jampachaisri, C. Norman Scholfield, and Kornkanok | Lipolytic |
| Oryza Sativa Bran Oil (Rice Oil) | Ingkaninan | Carrier oil |
| Hydrogenated Castor Oil | | Carrier oil |

| | | |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Sesamum Indicum Seed Oil (Sesame Oil) | <i>An integral topical gel for cellulite reduction: results from a double-blind, randomized, placebo-controlled evaluation of efficacy</i> , Eric Dupont, Michel Journet, Marie-Laure Oula, Juan Gomez, Claude Léveillé, Estelle Loing, Diane Bilodeau | Antioxidant, Anti-inflammatory Increase the integrity of extracellular matrix |
| Triticum Vulgare Germ Oil (Wheat Germ Oil) | Journet, Marie-Laure Oula, Juan Gomez, Claude Léveillé, Estelle Loing, Diane Bilodeau | Antioxidant |
| Coffea Arabica Seed Extract | <i>Botanical Extracts Used in the Treatment of Cellulite</i> , Doris Hexsel, Cecilia Orlandi, Debora Zechmeister do Prado | Lipolytic |
| Coffea Arabica Seed Extract | <i>Cellulite Reduction by Modified Thai Herbal Compresses; A Randomized Double-Blind Trial</i> Ngamrayu Ngamdokmai, MSc, Neti Waranuch, PhD, Krongkarn Chootip, PhD, Katechan Jampachaisri, PhD, C. Norman Scholfield, PhD, and Kornkanok Ingkaninan, PhD | Lipolytic |
| Olea Europaea Oil (Olive oil) | <i>The application of caffeine as anti-cellulite component of body lotion</i> , Zięba Małgorzata, Witkiewicz Elżbieta | Carrier oil |
| Butyrospermum Parkii Butter (Shea butter) | | |
| Hippophae Rhamnoides Seed Extract (Sea Buckthorn Oil) | <i>Botanical resources of spontaneous and cultivated flora, with application in the cosmetic industry</i> , Gheorghe-Virgil Atodiresei | Antioxidant Nourish the skin Stimulates collagen synthesis (phytosterols, carotenoids, tocopherols) |
| Calendula officinalis oil extract | | Antioxidant, anti-inflammatory (carotenoids, flavonoids) |
| Prunus Amygdalus Dulcis Oil (Almond Oil) | <i>Anti-cellulite effect of black pepper and rosemary oil rich balm</i> Alista Chumnanna, Cheevarat Yoopensuk and Narunan Wuttisin | Penetration enhancer |

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| | | |
|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Carthamus Tinctorius Seed Oil (Safflower Oil) | <i>Cellulite skin treatment methods and composition,</i> Inventors: Candace R. Keefe, Laguna Beach, Michelle Arth, Aliso Viejo, Antoaneta Abbruzzese, Pierre Bottiglieri, Conthey-Sion | Moisturizer |
| Seed Oil Glycine Soia (Soybean) | | Moisturizer |
| Helianthus Annuus Seed Oil (Sunflower Oil) | | Moisturizer |
| Simmondsia Chinensis Oil (Jojoba Oil) | | Moisturizer |
| Seed Oil Butyrospermum Parkii (Shea Butter) | | Moisturizer |
| Olea Europaea (Olive) Fruit Oil | | Moisturizer |
| Prunus Amygdalus Dulcis Oil (Almond Oil) | <i>Thermo slimming cosmetic composition</i> Inventors: Liliane Ayache, Paris; Jean-Pierre Laugier, Antony, both of France | Carrier oil |
| Persea Gratissima Oil (Avocado Oil) | | Carrier oil |
| Castor Oil | | Carrier oil |
| Olea Europaea Oil (Olive oil) | | Carrier oil |
| Simmondsia Chinensis Oil (Jojoba Oil) | | Carrier oil |
| Helianthus Annuus Seed Oil (Sunflower Oil) | | Carrier oil |
| Triticum Vulgare Germ Oil (Wheat Germ Oil) | | Carrier oil |
| Prunus persica (Peach) Kernel Oil | | Carrier oil |
| Seed Oil Butyrospermum Parkii (Shea Butter) | Carrier oil | |
| Corylus Avellana Seed Oil (Hazelnut Oil) | Carrier oil | |
| Carthamus Tinctorius Seed Oil (Safflower Oil) | Carrier oil | |
| Cocos Nucifera Oil | Carrier oil | |
| Glycine Soja Oil (Soybean Oil) | Carrier oil | |
| Peanut Oil | Carrier oil | |
| Vitis Vinifera Seed Oil (Grape Oil) | Carrier oil | |
| Sesamum Indicum Seed Oil (Sesame Oil) | Carrier oil | |
| Shorea robusta seed oil | Carrier oil | |
| Palm Oil | Carrier oil | |

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|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Seed Oil Glycine Soia (Soybean) | <i>Lipolysis stimulator</i> Inventors: Minoru Takizawa, Mayumi Sato, Hiroshi Kusuoku, Mitsuyoshi Sakasai | Carrier oil |
| Castor Oil | | Carrier oil |
| Prunus persica (Peach) Kernel Oil | | Carrier oil |
| Prunus Amygdalus Dulcis Oil (Almond Oil) | | Carrier oil |
| Persea Gratissima Oil (Avocado Oil) | | Carrier oil |
| Simmondsia Chinensis Oil (Jojoba Oil) | | Carrier oil |
| Oryza Sativa Bran Oil (Rice oil) | | Carrier oil |
| Theobroma Cacao Seed Butter | | Carrier oil |
| Sesamum Indicum Seed Oil (Sesame Oil) | | Carrier oil |
| Ximenia Americana Seed oil | <i>An Overview on the Properties of Ximenia Oil Used as Cosmetic in Angola</i> , Gabriel Satoto, Ana Sofia Fernandes, Nuno Saraiva, Fernando Santos, Nuno Neng, José Manuel Nogueira, Tânia Santos de Almeida, Maria Eduarda Araujo | Strengthen vascular wall (ximenynic acid) |
| Centella asiatica extract (oil) | <i>Pentacyclic Triterpenoids from the Medicinal Herb, Centella asiatica</i> , (L.) Urban Jacinda T. James and Ian A. Dubery | Lipolytic, Activates microcirculation (asiaticozids) |
| Centella asiatica extract (oil) | <i>Tetracyclic and Pentacyclic Triterpenes with High Therapeutic Efficiency in Wound Healing Approaches</i> , Roxana Ghiulai, Oana Janina, Rosca Diana Simona Antal, Marius Mioc, Alexandra Mioc, Roxana Racoviceanu, Ioana Maca, Tudor Olariu, Cristina Dehelean, Octavian Marius, Mirela Voicu, Codruta Soica | Contains saponified triterpenes, triterpenic acids (lipolytic role, activates microcirculation) |
| Glycine soja oil | <i>Cosmetic or cosmetic product for firming and soothing the skin in particular in the case of cellulite</i> Inventors: Alfred Schmidt Heinrich Wieland | Oxidized glycine soja, inhibits aromatase enzyme, lowering the estrogen level from adipose tissue, reducing edematous cellulite |

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| | | |
|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Seed Oil <i>Butyrospermum Parkii</i> (Shea Butter) | <i>Anti- cellulite cream</i> Inventors: Jan L. Marini, Subhash J. Saxena | Carrier oil |
| Glycine soja oil | | Conditioning skin agent |
| <i>Helianthus Annuus</i> Seed Oil (Sunflower Oil) | | Conditioning skin agent |
| Allium cepa seed oil | <i>Stability and extraction of bioactive sulfur compounds from Allium genus processed by traditional and innovative technologies</i> Authors: Mahesha M. Poojary, Predrag Putnik, Danijela Bursac Kova, Francisco J. Barba, Jose Manuel Lorenzo, Daniel A. Dias, Avi Shpigelman | Weight loss in rats given Allium cepa seed oil orally (92.6 mg/kg 60 days) The sulfur compounds in the composition have a lipolytic role. Kaempferol from Allium cepa has a lipolytic role, inhibits adipogenesis. |
| | <i>Physical, chemical and bioactive properties of onion (Allium cepa L.) seed and seed oil</i> , Hasan Yalcin, Hatice Kavuncuoglu | |
| | <i>Allium cepa: A Treasure of Bioactive Phytochemicals with Prospective Health Benefits</i> , Arka Jyoti Chakraborty, Tanvir Mahtab, Uddin, B. M. Redwan Matin Zidan, Saikat Mitra, Rajib Das, Firzan Nainu, Kuldeep Dhama, Arpita Roy, Md. Jamal Hossain, Ameer Khusro, Talha Bin Emran | |

In addition to the clinical studies founded in the two scientific databases, we studied the oils recommended by European distributors as anticellulite vegetable oils. Among those, andiroba oil and chaulmoogra oil have a clinically proven anticellulite effect.

Andiroba oil (*Carapa guianensis* Aubl.)

Andiroba oil contains: fatty acids (palmitic acid, stearic acid, arachidic acid, hexadecenoic acid, oleic acid, linoleic acid, linolenic acid), meliacins and oxygenated terpenes similar to quassinoids, responsible for the lipolytic effect.

The lipolytic effect, demonstrated in vitro, takes place through a mechanism of inhibition of the enzyme glucose-6 phosphate dehydrogenase. Inhibition of the enzyme glucose-6 phosphate dehydrogenase leads to a decrease in the formation of NADPH, implicitly to a decrease in the synthesis of fatty acids. (Fig 2.)

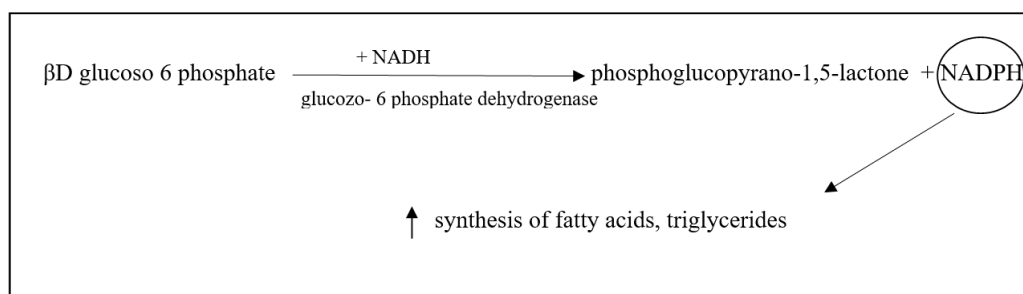


Fig 2. The role of glucose-6 phosphate dehydrogenase in fatty acid synthesis

Also in vitro, the same study shows that andiroba oil inhibits adipocyte synthesis, by blocking glucose-3 phosphate dehydrogenase activity.[11]

Chaulmoogra oil (*Hydnocarpus wightiana*)

The lipolytic properties of chaulmoogra oil are due to its chemical composition, the presence of gorlic, chaulmoogric, hydnocarpic acids. (Fig. 3)

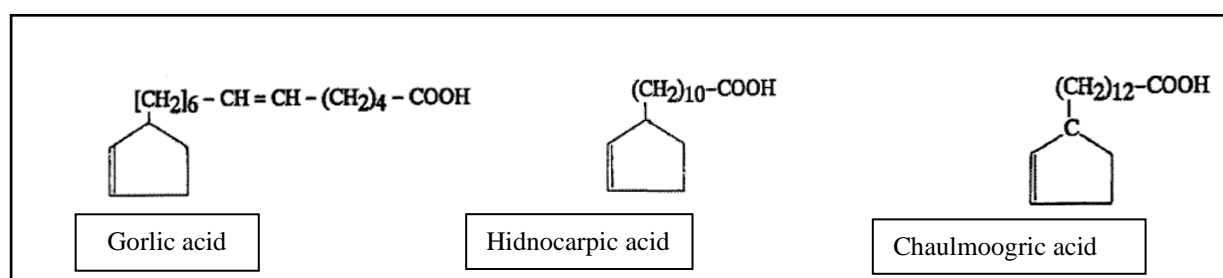


Fig. 3. Gorlic acid, Chaulmooghric acid, Hidnocarpic acid.

The lipolytic effect is due to the inhibition of alpha receptors and competition for the neuropeptide Y receptor, both of them decrease cyclic AMP and promote lipogenesis.[12]

Conclusions

In this review, one thousand scientific articles were studied but only twenty-three articles met the search criteria. We also studied the vegetable oils already existing in the anticellulite cosmetic industry and vegetable oils recommended by the European distributors as having an anticellulite effect. From the twenty-three scientific articles with anticellulite formulations that contain vegetable oils, we highlighted fifteen scientific researches in which vegetable oils have an actual anticellulite effect. The oils with an anticellulite effect already existing in the cosmetic industry, those recommended by European distributors and the fifteen

oils found in scientific researches, have been systematized in a table that highlights the anticellulite mechanisms of each oil. (table 4) The anticellulite mechanisms are inhibition of lipogenesis, the increase of lipolysis, the decrease of adipogenesis, activation of microcirculation, activation of extracellular matrix synthesis, the increase of the integrity of the extracellular matrix, the decrease of inflammation and the reduction of oxidative stress. [13]

There are twenty nine vegetable oils with an anticellulite effect, two of them have a benefic effect in edematous cellulitis, four in adipose cellulitis and twenty three in fibrous cellulitis. (Table 4)

Table 4. List of oils with an anticellulite effect demonstrated by clinical studies. The number in each box represents the scientific reference number attesting to the respective anticellulite mechanism.

| Oils | Adipo genesis ↓ | Lipolysis ↑ | Lipogenes is ↓ | Micro circulation ↑ | Synthesis MEC ↑ | MEC Integrity ↑ | Inflamation ↓ | Oxidation ↓ |
|-------------------------|--------------------|-------------|-------------------|------------------------|--------------------|--------------------|---------------|-------------|
| Kernel Oil | | | | | | | | 14 |
| Jojoba Oil | | | | | 15,16 | 15,16 | 15,16 | 15,16 |
| Wheat Germ Oil | | | | | 17 | 17 | 17 | 18 |
| Hemp Oil | | | | | 19 | 19 | 19 | 19 |
| Almond Oil | | | | | 20 | 20 | 20 | 20 |
| Coffee butter | | 21,22,23 | | | | | | |
| Andiroba Oil | 11 | | 11 | | | | | |
| Sunflower Oil | | | | | | 25 | 25 | |
| Grape Seed Oil | | | | | 24 | 24 | | 24 |
| Rice Oil | | | | | | | 26 | 26 |
| Cacao Butter | | | | | 27 | 27 | | 27 |
| Argan Oil | | | | | 28,29 | 28,29 | | 28,29 |
| Avocado Oil | | | | | 30 | 30 | 30 | |
| Soybean Oil | | | | | 31 | 31 | 31 | 31 |
| Sea Buckthorn Oil | | | | | 32 | 32 | | 32 |
| Safflower Oil | | | | | 33 | 33 | | 33 |
| Daisy Oil | | | | | 34 | 34 | 34 | 34 |
| Shea Butter | | | | | | | 35 | 35 |
| Macadamia Oil | | | | | | | 36 | 36 |
| Chaulmoogr a Oil | | 12 | | | | | | |
| Hazelnut Oil | | | | | | | | 35 |
| Touloucouna Oil | | | | | | | | |

| | | | | | | | | |
|-------------------------|----------|----------|--|-------------|-------|-------|----|-------|
| Evening Primrose Oil | | | | | 37 | 37 | | |
| Centella asiatica Oil | | 38,39 | | 38,39,40,41 | 40,41 | 40,41 | | 38,39 |
| Sesame Oil | | | | | | 42 | 42 | 42 |
| Hydrogenated Castor Oil | | | | | | | | |
| Olive Oil | | | | | | | 35 | 35 |
| Calendula Oil | | | | | | | 32 | 32 |
| Coconut Oil | | | | | 35,43 | 35,43 | 35 | 35 |
| Shorea robusta Seed Oil | | | | | 44 | 44 | | |
| Peach Oil | | | | | | | | 45 |
| Palm Oil | | | | | | | | |
| Ximenia Americana Oil | | | | 46 | | | | |
| Allium cepa Oil | 47,48,49 | 47,48,49 | | | | | | |

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