

# Comparative analysis of anti-cellulite market products containing vegetal cosmetic assets

## Abstract

**Introduction:** Cellulite is characterized by a weakness of the fascia which accumulates fat lobules alongside irregular lobular hypertrophy that causes skin dimpling and occurs mostly in women after puberty. Cellulite may arise from a sum of different conditions, such as emotional alterations, genetics, sedentary lifestyle, hormones, weight gain and poor nutrition. There are several techniques designed to prevent and treat cellulite, but consumers prefer topical lotions and creams due to them being more affordable. This work aimed to review studies published in scientific literature on major plant-based active ingredients used in anti-cellulite formulations commonly available to consumers.

**Methodology:** Nine formulations available to consumers were reviewed: 3 from Brazilian companies, 3 from US companies and 3 from European companies.

**Results and discussion:** The main active ingredients found in products claiming to reduce cellulite damage are: asiaticoside (obtained from *Centella asiatica*), Saponin (found in horse chestnut), *Hedera helix* (found in ivy), and caffeine.

**Conclusion:** There is a great diversity and vegetal assets; however, the most used are caffeine, for its lipolytic action, centella asiatica for presenting its anti-inflammatory action, ivy for improving circulation due to its action of vasoconstrictor and chestnut India that helps in strengthening vessels. Cosmetics are often used as a co-adjuvant of other techniques, such as modeling massage and ultrasound, which makes the active more easily penetrate the skin. Similar raw materials are incorporated into the cosmetic formulations with the skin, which will hydrate it, thus facilitating the penetration of the active substance into the skin.

**Keywords:** plant-based active ingredients, aesthetic treatment, cellulite

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## Introduction

Cellulite was first described in 1920 by Paviot and Alquier as a non-inflammatory process of the mesenchymal tissue.<sup>1</sup> Inflammation is a defensive response that takes place after cells suffer damage and is generally beneficial as it limits the invasion of pathogens. Cellulite thus is not considered an inflammatory process, according to Lima's Ecologists (2007).<sup>2</sup>

There are several terms used to describe cellulite, but "Gelloid Fibro Edema" (GFE) is the most appropriate term, as it is a disorder that affects both dermis and subcutaneous tissue, causing alterations in the skin surface conferring an appearance of "orange peel" to it. Factors such as genetics, emotional elements, metabolism and hormones contribute to development of cellulite.<sup>1,3-6</sup> The onset of cellulite happens at puberty, when there is an increase of the number of fat cells and estrogens.<sup>7,8</sup> This hormonal change is responsible for alterations in collagen metabolism, increase of alpha-antilipolytic receptors stimulating lipoprotein lipase (LPL), and enzymes responsible for lipogenesis.<sup>3,4,9</sup> LPL, a hydrolytic enzyme expressed in many tissues, restricts the removal rate of lipoprotein triglycerides from the blood stream. It has other functions in many normal tissues as well as in some metabolic diseases, including obesity.<sup>10</sup>

Adipose cells accumulate fat and become larger. This results in impairment of venous and lymphatic microcirculations. The enlargement of adipocytes and impaired circulation are a mechanism for skin dimpling.<sup>1,3,4,9</sup> as weakness in the fascia and the role of lipedema in the process.

Cellulite can develop in several parts of the body, most commonly

in the gluteal region, thighs, abdomen and posterior arms. It is classified into four stages based on severity:

- Cellulite grade I → skin irregularities cannot be observed by the naked eye, but sight enhancing tools and histology allows their detection
- Cellulite grade II → changes in the skin surface can be detected with no need for compressing the skin, but the skin has not yet reached "orange peel appearance"
- Cellulite grade III → vascular changes interfere with skin metabolism and the "orange peel" appearance develops;
- Cellulite grade IV → the collagen fibers become stiffer, circulation becomes impaired and deep skin irregularities develop.<sup>5,9,11</sup>

## Plant-based ingredients used for cellulite treatment

Plant-based cosmeceuticals are routinely used in dermatological products. Emotional elements, metabolism and hormones contribute to cellulite.<sup>1,3-6</sup> Cellulite presents at puberty, at which time there is an increase of fat cells and hormone estrogen.<sup>7,8</sup> This hormonal change is responsible for alterations in collagen, an increase in alpha-antilipolytic receptors stimulating lipoprotein lipase (LPL), and an enzyme responsible for lipogenesis.<sup>3,4,9</sup> Such cosmeceuticals are divided into three groups: phenols, terpenes and alkaloids.<sup>12</sup>

## Main plants used in anti-cellulite products

Among several species, the most frequently used in products for cellulite are coffee, centella, horse chestnut, ginkgo biloba, ivy, guarana and rue.

### Coffee (*Coffea arabica* L.)

Caffeine, a xanthine alkaloid, is extracted mainly from *Coffea arabica* L., but can also be found in fruits and flowers of other plants. It acts in adipose tissue activating lipolysis by inhibiting the actions of phosphodiesterases and increasing the levels of cyclic adenosine monophosphate (cAMP).<sup>7,13</sup>

### Centella asiatica (*Hydrocotyle asiatica* L.)

Centella asiatica belongs to the Apiaceae family and its main secondary metabolite is asiaticoside. It strengthens the supporting structures of connective tissue and improves vessel circulation and blood flow, attenuating the symptoms of cellulite. Centella also increases the lysine and proline metabolism, which are fundamental for sustaining collagen. The amount considered suitable for topical products ranges from 2 to 5%.<sup>4,7,13</sup>

### Horse chestnut (*Aesculus hippocastanum* L.)

Horse chestnut belongs to the Hippocastanaceae family and its main chemical bioactive compound is Saponin. It has anti-inflammatory and vasoprotective actions.<sup>13,14</sup>

### Ginkgo biloba (*Ginkgo biloba* L.)

*Ginkgo biloba* belongs to the *Ginkgoaceae* family and its major constituents are amino acids, flavonoids and proanthocyanidins (terpenoids). The seeds contain alkaloids and amino acids. It has vasodilating and anti-inflammatory actions, slowing down collagen metabolism decreasing edema.<sup>4,7,13,14</sup>

### Ivy (*Hedera helix* L.)

*Hedera helix* belongs to the *Araliaceae* family, and its main constituent is also Saponin. It possesses vasoconstrictor properties, prevents the formation of edemas and improves drainage of body liquids.<sup>15,16</sup>

### Arnica (*Arnica montana* L.)

*Arnica Montana* belongs to the *Asteraceae* family and has as secondary constituent's alkalis, amines, carbohydrates, coumarins and flavonoids. These compounds stimulate the skin tissue, improving blood flow and increasing fibrin resorption.<sup>13,14,17</sup>

### Guarana (*Paullinia cupana* K.)

*Paullinia cupana* belongs to *Sapindaceae* family and its main chemical is caffeine. It increases blood flow and dilates vessels, also possessing lipolytic actions.<sup>7,17</sup>

### Rue (*Ruta graveolens* L.)

*Ruta graveolens* belongs to *Rutaceae* family and its major ingredient is rutin, a flavonoid. It has anti-inflammatory actions and increases vascular permeability.<sup>17</sup> This study aimed to review scientific literature on the major plant-based active chemicals used in national and international anti-cellulite products often purchased by consumers.

## Methodology

This study is a bibliographical review compiling information taken from scientific articles. The databases consulted were Scielo, Pubmed, Bireme and academic websites. Articles published between 2005-2015

were assessed, the keywords used for searches being: gelloid fibro edema, active chemicals for treatment of cellulite, topical products for treatment of cellulite, plants for treatment of cellulite. Other sources used included specific cosmetology books in Portuguese such as: International "Treaty of Cosmeceuticals"; "Cellulite, Prevention and Treatment" and "Cosmetology Science and Technology".

### Criteria

Articles containing the following terminology were selected: fibro gynoid edema, hydrolipodystrophy, and plant actives. For evaluation of formulations, websites, drugstores and product catalogs sold directly to consumers were assessed. Treatments were also assessed, but for discussion purposes only items relevant to the nine products here described were evaluated. Nine plant-based cosmeceutical products that are used for cellulite treatment were assessed, three products from Brazilian companies, three products from US companies and three products from European companies.

## Results and discussion

### Evaluation of anti-cellulite products

A label analysis for each product was carried out by checking the functions of each component of the formulations and their efficacy, such as humectants, emollients and thickeners.

The first formulation assessed is *Imecap Cellut* of the Brazilian company DIVCOM PHARMA, which claims it has the "toughest treatment for cellulite, fighting fat". The formulation contains three humectants, glycols, a thickener derived from polyethylene glycol and six emollients derived from esters. The extracts are from *Ruta graveolens* leaf (Arruda), *Ginkgo biloba* leaf (Ginkgo biloba), *Arnica Montana* flower (Arnica), *Aesculus hippocastanum* seed (Horse chestnut), *Hydrocotyle asiatica* (Centella asiatica); *Hedera helix* (Hera) and *Coffea arabica* (Coffee). The second formulation is *Creme Anticellulite Ecologie*. According to its manufacturer, BRILL, it is a cream that prevents cellulite development by inhibiting fat storage. The high spread ability of the product on the skin is due to the presence of isopropyl palmitate emollient. The amount of plant extracts is lower compared to the amount found in the previous formulation, and only three active ingredients can be found: saponin from *Hedera helix* (conferring anti-edematous properties) asiaticoside from *Centella asiatica* (improving microcirculation) and caffeine (which improves the lipolytic metabolism).<sup>4,15,17-19</sup>

The third formulation is *Anticellulite Firming Body Lotion Firmness Intensive*. According to the company NUPILL, its manufacturer, the lotion retraces the skin undulations and shrinks their silhouette. It reduces inflammation, stimulates skin lipid synthesis and has a moisturizing action. Its formulation contains "Slimbuster H", a bio complex of plants with draining and lipolytic actions that minimize the aspect of "orange peel" on the skin. In addition to this bio complex the formulation also contains extract from *Centella asiatica*, which improves the microcirculation.<sup>9</sup> The fourth formulation is *Celluvin* from the SENVIE company, produced in the United States. The manufacturer claims that within seven days of use positive results can be seen. The cream is a combination of several plant-based antioxidants, three moisturizers of the glycol class, two thickeners derived from polyethylene glycol, other compounds derived from polysaccharides and five emollients, two of them derived from esters and the other three derived from fatty acids, caffeine, and guarana.<sup>7</sup>

The fifth formulation is *Body Cellu-Sculpt Cream* from the American company AVON. The product consists of three humectants of the glycol class and four emollients, one being phytol, which is a component of chlorophyll, intended to improve skin tonicity. It contains two active plant chemicals, a flavonoid from *Ginkgo biloba*, which improves vascular tonus and circulation, and caffeine, which has lipolytic actions reducing the size of fat cells.<sup>4,9</sup> The sixth formulation is *Cellulite Control Body Glow CC Cream* from the American OSMOSTICS COSMECEUTICALS Company. According to the manufacturer, the product reduces the silhouette and minimizes the appearance of dimpling on the skin surface. Its formulation contains a humectant derived from glycols, an emollient derived from esters and caffeine as an active lipolytic.<sup>9</sup>

The seventh formulation is the *Reducing Body Emulsion Drainage* from the Italian LGM company. The product is designed to treat cellulite with oils and plant extracts with lipolytic action. Its formulation is composed of two moisturizing agents, one derived from glycols and the other from fatty acids, and two softeners, one from esters of fatty acids and the other from horse chestnut, *Centella Asiatic* and Ivy. The eighth formulation is the anti-cellulite gel *Attack Perfect Body* from the ORIFLAME Company. Unlike the other formulations here mentioned, it possesses a “built-in massager package”. According to the company, the “massage package” improves the actions of the formulation by activating the peripheral microcirculation. The formulation contains three moisturizers of the glycol class, three emollients derived from silicones and only one active plant chemical, caffeine from *Paullinia cupana* (Guarana), which confers lipolytic properties to the formulation.<sup>7,9,20</sup>

The ninth and final assessed formulation is the *Bio Crema Anticelulite* from the NEEM ITÁLIA Company. According to the manufacturer, the use of the cream provides fast results; it contains caffeine, asiaticoside from *Centella asiatica* and saponins from Horse chestnut. Tables 1, 2 & 3 summarize the amount of components found in each formulation designed for treatment of cellulite, such as thickeners, humectants, emollients and plant-based active chemicals.

**Table 1** Amount of technological components and plant active compounds in anti-cellulite products from Brazilian companies

	Imecap Cellut DIVCOM PHARMA	Creme anticelulite Ecologie BRILL	Loção corporal firmadora anticelulite NUPPIL
Moisturizer	3	3	1
Thickeners	1	1	-
Emollients	6	3	3
Plant-based actives	7	3	1

**Table 2** Amount of technological components and plant active compounds in anti-cellulite products from US companies

	Celluvin SENVIE	Crème Body Cellu-Sculpt AVON	Celulite Control Body Glow OSMOTICS
Moisturizer	3	3	1
Thickeners	2	1	1
Emollients	5	4	1
Plant-based actives	2	2	1

In addition to the plant-based actives, the formulations are composed of a combination of other materials such as emollients,

thickeners and moisturizers that facilitate the product permeating into the skin. According to the analysis of the anti-cellulite formulations, it can be inferred that products from Brazilian companies tend to have the least sensorial properties; these products, when applied to the skin, non-comedogenic touch, and contain more active compounds combined in a single formulation. Cellulite products from US and European companies have more unctuous formulations of higher comedogenicity due to the presence of saturated esters, fatty acids and alcohols as emollients.<sup>18</sup> On the other hand, these products are much more moisturizing in comparison to Brazilian products. Products from US companies have fewer plant active chemicals in their formulations in comparison to formulations of products from Brazilian and European companies assessed in this study.

**Table 3** Amount of technological components and plant active compounds in anti-cellulite products from European companies

	Reducing Body emulsion Drainage LGM ITALIA	Attack Perfect Body ORIFLAME	Bio Crema Anticelulite NEEM ITALIA
Moisturizer	3	3	1
Thickeners	1	-	-
Emollients	2	3	3
Plant-based actives	3	1	3

A fully functional skin barrier provides various benefits to the skin, such as improved epithelial integrity, hydric balance, organized comeocytic exfoliation as well as facilitating penetration of substances into the skin.<sup>6,17,18</sup> Skin hydration is especially important, as it promotes better balance of water and lipids, which facilitates penetration of active compounds.<sup>19</sup> Table 4 compiles the analysis of components from all formulations assessed, manufactured in Brazil, US and Europe. Formulations containing compounds with large carbon chains and unsaturated chains are more comedogenic and unctuous. Formulations containing compounds of branched carbon chains tend to have a “dry touch.”<sup>18</sup>

**Table 4** Comparison of formulations manufactured by companies from Brazil, United States and Europe

	Brazil	United States	Europe
Sensorial properties	Soft	Unctuous	Unctuous
Comedogenic	No	Yes	Yes
Plant-based actives	11	5	7
Moisturizers	7	7	7
Thickeners	2	4	1
Emollients	12	10	8

### Analysis of effectiveness of plant chemicals associated or not with cosmetic procedures

Cellulite is a problem which affects over 90% of women worldwide.<sup>6,21,22</sup> There is a wide variety of aesthetic treatments described in scientific literature for treatment of cellulite; these treatments can be either invasive or non-invasive, making use or not of cosmeceuticals.<sup>9,11</sup>

Mesotherapy is an invasive technique that consists of intradermal application of substances in order to stimulate lipolysis, reducing the fat content of the skin. In a study by Chorilli et al.<sup>23</sup> the authors tested

solutions of 2% caffeine, tiratricol and 0.035% hyaluronidase applied on male pigs for 13 days throughout four sessions. The pigs were separated into different test groups receiving different treatments: blank testing (no solution); control (2 mL of saline solution); 2 mL of tiratricol solution; 2 mL of caffeine solution; 2 mL of hyaluronidase solution. Animals were euthanized on day 15. The study showed that the use of caffeine solution on the skin caused a flattening of the lobes of adipose tissue and reduced the thickness of the subcutis.

Ultrasound is used to accelerate the transport of substances transdermally. In a study by Polacow et al.<sup>24</sup> tiratricol was tested as a lipolytic substance. The authors subjected six different groups of male pigs to different treatments: topical gel (G) alongside massage in order to observe hyperemia (10 minutes); topical gel alongside ultrasound (L + US); topical gel containing tiratricol (G + T) alongside massage following the same parameters for group G; topical gel containing tiratricol alongside ultrasound (G + T + US); mesotherapy (M); control (C). The authors reported the group of pigs subjected to treatment with gel containing tiratricol alongside ultrasound reduced the hypodermis in addition to reducing adipose tissue lobules.

In a study by Federico et al.<sup>25</sup> phonophoresis with a 3 MHz ultrasound device was used alongside topical application of a gel containing ivy, spar and horse chestnut extracts on five volunteers aged between 20-26. The volunteers were divided into two groups: A (2), doses of 1.5 watts/cm<sup>2</sup> and B (3), doses of 1.1 watts/cm<sup>2</sup> spread throughout 16 treatment sessions, sessions per week. Only one of the five volunteers had a positive response, two did not respond satisfactorily to the treatments and two were damaged at the end of the treatments. It was concluded by the authors that the use of cosmetics in association with ultrasound is an adequate technique, however, only 4 weeks of treatment were not enough in order to conclude whether the treatments can lead to satisfactory results or not. Only one of the volunteers who had been subjected to a dose of 1.5 watts/cm<sup>2</sup> responded satisfactorily to the treatment.

In a study by Ramalho et al.<sup>26</sup> the efficacy of three formulations containing caffeine as an active chemical for the treatment of cellulite was assessed. The test groups were divided as follows: 99 volunteers (aged 18 to 44) having cellulite grade II and III were treated for 30 days with a gel containing caffeine; 40 volunteers (aged 26 to 74) having cellulite grade II, III and IV were treated for 30 days with a cream containing black pepper, bitter orange, ginger, cinnamon, chillies and caffeine; 40 female and 1 male volunteers (aged 25 to 65 years) were treated for 30 days with a cream containing 20 ingredients, among them caffeine. The three tests with formulations containing caffeine as an active ingredient were reported to be effective for treatment of cellulite. The best results were obtained when volunteers were treated with formulations containing active compounds encapsulated in liposomes.

In a study by Fabris et al.<sup>27</sup> the authors assessed the efficacy of a fat reducing gel containing caffeine, ivy, horse chestnut, horsetail and centella. The gel was applied on 10 volunteers (aged 20 to 53 years) for 10 days on the abdominal region. It was observed that 7 out of the 10 volunteers responded positively to the treatment with evidenced reduction of abdominal circumference. The results were attributed to improved blood circulation which decreased the swelling caused by retention of water.

## Conclusion

Fibro edema or cellulite edema is a skin abnormality common in

females which is not caused by an anti-inflammatory process, but instead by a lipid imbalance of water. There are several aesthetic procedures aimed at treating cellulite, such as ultrasound, lymphatic drainage, vacuum therapy, among others; the efficacy of these treatments has already been evidenced in studies found in scientific literature. However, cosmeceuticals are more commonly preferred for treatment of cellulite due to them being more affordable. There is a wide variety of compounds used for treatment of cellulite, but the most commonly used are caffeine due to its lipolytic action, asiaticoside found in *Centella asiatica* due to its anti-inflammatory properties and saponins found in Horse Chestnut and Ivy due to its ability to improve circulation, strengthening blood vessels.

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## Conflicts of interest

Authors declare that there are no conflicts of interest.

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