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HASS AVOCADO: A POTENTIAL IN THE INDUSTRY FOR ITS BIOACTIVE COMPOUNDS AND BENEFITS FOR HEALTH

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ABSTRACT.

Hass avocado is a fruit with different bioactive compounds including monounsaturated fatty acids (palmitoleic, oleic and gadoleic), 13% polyunsaturated acids (linoleic, alpha-linolenic) and 16% saturated acids (palmitic, stearic, arachidic) (Araujo, 2018); abundance oleic acid (omega 9) 53.44 % among others. It may have a main role to prevent different heart diseases and even cancer cells. It is recommended to consume it in the daily diet.

Keywords: Avocado, bioactive compounds, health, benefits

Introduction.

Avocado emerged from pre-Columbian era and it has been the diet of different cultures in America (Campos, 2018). Its name derives from the Aztec word "ahuacatl" which means testicle (Araujo, 2018); its cultivation began about 6000 years (Costagli and Betti, 2015). Among the fruits, the avocado (*Persea americana* Mill.) belongs to the *Lauracea* family which consists of 52 genders and about 3500 species, of which 70 grow in warm regions of America (Chin, 2019).

Nowadays it has more value in the international market due to its nutritional quality, its uses, health benefits and for the cosmetic industry (Pérez et al., 2015). It is currently known that its inclusion in the diet plays a very important role, for example, its antioxidants can minimize the free radicals that are generated in various biochemical and physiological processes or by environmental factors, avoiding alterations in the regeneration of cell tissues (Beltran, 2016).

In the market, today it is the most sold tropical fruit, representing a third of the production in the world (FAO, 2018), with Mexico occupying the first place worldwide in production, contributing 50% (1,100,000 tons of fruit), which is sold in more than 30 international markets (SENASICA, 2020), highlighting in the Mexican States Michoacan and Nayarit (Castañeda, 2015).

Recently food, pharmaceutical, cosmetic and nutraceutical industries have shown interest in the lipidic pulp Hass avocado composition due to the presence of fatty acids monounsaturated (Rios, 2018); particularly the oleic acid, which has a lipid lowering effect, being this one of the main reasons to be consumed as an important high nutritional value, including carnitine in its composition which was considered only to be present in meat products; this substance is involved in the metabolism of the heart muscle, and it is used for the treatment of heart diseases (De Souza et al., 2015; Perez, 2015). It is also called protective fruit (Cowan and Wolstenholme, 2016), due to the presence of nutrients such as lutein, a powerful antioxidant, called "yellow carotenoid" (Vivero, 2019); It has also been reported the hepatoprotective ability due to its content of flavonoids and phenolic compounds, and the inhibition of cancer cell lines due to its content of tocopherols, carotenoids and bioactive compounds (Gupta et al., 2018).

Composition of avocado pulp

The nutritional composition of the avocado pulp is: moisture content (67-85%), lipids (12-24%), carbohydrates (0.8-1.5%) and fiber (1.4-3.0%) (Cowan and Wolstenholme, 2016; Dijkstra, 2016). Its lipid content in general terms is represented by 71% monounsaturated fatty acids (palmitoleic, oleic and gadoleic), 13% polyunsaturated acids (linoleic, alpha-linolenic) and

16% saturated acids (palmitic, stearic , arachidic) (Araujo, 2018); abundance oleic acid (omega 9) 53.44 % (De Souza et al., 2015). It is important to mention that this composition depends on the agriculture, maturity, the fruit and the geographic location (Sivakumar, 2018). Regarding other compounds, it also contains protein, approximately 2.3% on a fresh weight basis, this percentage is between two and ten times higher compared to other fruits and vegetables.

It provides minerals such as potassium (507 mg/100g), phosphorus (54mg/100g), magnesium (29 mg/100g), calcium (13 mg/100g) and others (Araujo et al., 2018); vitamins, it provides β-carotene (63 mg/100g), vitamin E (1.97 mg/100g), retinol (7 mg/100g), ascorbic acid (8.8 mg/100g), thiamine (0.08 mg/100g), riboflavin (0.14 mg/100g), niacin (1.91 mg/100g), pyridoxine (0.26 mg/100g) and folic acid (89 mg/100g) (Figure 1) (Araujo et al., 2018).

As mentioned above, this fruit is recognized for its health benefits, especially due to its compounds and referred to the lipid fraction (omegas, phytosterols, lutein, tocopherols and squalene), as well as vitamins, minerals and antioxidants, whose benefits are also associated to a balanced diet, especially to reduce cholesterol and prevent cardiovascular diseases due to its low content of saturated fatty acids (Fonseca et al., 2016). It is appropriate for human consumption, as well as an excellent source of healthy fat in diets (Estevam et al., 2018) .

On the other hand, avocado pulp contains a high amount of oil rich in phytosterol, carotenoids, aliphatic alcohols, tocopherols and hydrocarbons, its consumption also offers protection against atherosclerosis and thrombosis, and its phytochemicals can help in the prevention of cancer (Abaidea et al., 2017).

Figure. 1. Main nutrients in avocado

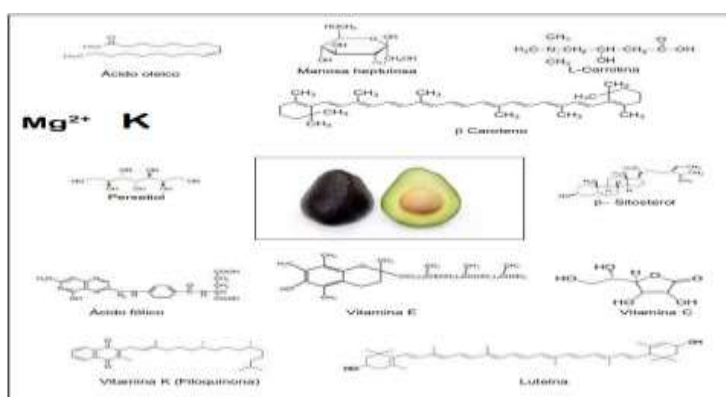


Fig. 1. Most abundant components in avocado. Source: Adapted from Avocado by-products : Nutritional and functional properties nutritional and functional properties. Araújo, et al. (2018). *Trends in Food Technology & Elsevier* (80), p. 53; Cowan, et al . (2016). Avocado. *Encyclopedia of Food and Health* p. 298 ; Bioactive compounds and possible health benefits of avocado. Vivero et, al. (2019) *Revista Chilena de Nutrición* , 46 (4), p. 491.

It is also reported that the extracts of Hass avocado pulp are chemo-preventive agents, effective in suppressing free radicals which are associated in carcinogenesis, so its consumption helps to protect against cancer, heart diseases and aging cell (Table 1) (Cowan and Wolstenholme, 2016; Estevam et al., 2018). Avocado oil can provide good effects in renal mitochondria of diabetic patients, decreasing the concentration of blood glucose as a result of a decrease of ROS (reactive species of oxygen) mitochondrial, both identified as key factors for the development of

diabetic nephropathy. This has led the search for strategies to reduce blood sugar levels and improving the redox state of glutathione, the main antioxidant that counteracts mitochondrial damage. Other studies include hypoglycemia effects, due to oleic acid, which has a probably dependence on glutathione and mitochondrial carriers (Ortiz et al., 2017). In addition, avocado skin and seeds are also rich in polyphenols with antioxidant and antimicrobial power (Table 2) (Segovia et al., 2018).

Table 1 . Health benefits of avocado components.

| Active principle | Health benefits | Reference |
|--|--|---|
| Lutein, yellow carotenoid | Prevents age-related macular degeneration (AMD) | Nursery, et al. (2019, p. 491). Fernández, Giaquinta, Laudo and Rojo (2017, p. 478) |
| Oleic acid (omega 9, sitosterol) | Lipid-lowering agent for the prevention and control of dyslipidemia. Antioxidant that counteracts mitochondrial damage. Accelerates the basal metabolic rate in humans. Decreases serum cholesterol levels, oxidation of LDL cholesterol and lowers blood pressure | De Souza, et al. (2015, p. 697). Ortiz, et al. (2017, p 4). Cowan and Wolstenholme (2016, p.296). Alvares, et al. (2019, p.2) |
| Persin (present in the leaves) | Anti-cancer effect; induction of apoptosis in human breast cancer cells | Gupta, et al. (2018, p. 49) |
| Flavonoids and phenolic compounds | Hepatoprotective effect | Gupta, et al. (2018, p. 4) |
| Tocopherols and carotenoids | Inhibition in the growth of prostate cell lines in vitro | Gupta, et al. (2018, p. 4) |
| Glycolipids and Phospholipids | For the construction of cell membranes | Araujo et al. (2018, p. 52) |
| Dietary fiber | Lipid-lowering and digestive effect | Nursery, et al. (2019, p. 491) |
| β-carotene (pro-vitamin A) and vitamin E (tocopherol) | Antioxidant and cardioprotective effect. Protective factor against the development of allergies in children | Araujo et al. (2018, p. 53) Abaidea, et al. (2018, p.291) |
| Glutathione | Powerful antioxidant that works against powerful carcinogens | Fonseca et al., (2016, p.749) |
| Monounsaturated fatty acids | They generate less resistance to insulin, improving blood glucose levels. | Del Toro, et al. (2016, p. 351) |
| Low sodium content | Blood pressure regulator | Cowan and Wolstenholme (2016, p. 298) |
| Polyphenols (catechin, epicatechin, and 3-leukoanthocyanidins) | Anti-inflammatory and anti-cancer properties | Segovia et al. (2018, p. 2) |

| | | |
|-----------|---------------------------|-------------------------------|
| Potassium | Regulates muscle activity | Fonseca et al., (2016, p.749) |
|-----------|---------------------------|-------------------------------|

Source: Adapted from: Bioactive Compounds and Potential Health Benefits of Avocado. Vivero, et al (2019). *Chilean magazine Nutrition* , 46 (4), p. 491 ; Avocado by-products : Nutritional and functional properties nutritional and functional properties. Araujo, et al. (2018). *Trends in Food Technology & Elseiver* (80), p. 53 ; Avocado. Cowan and Wolstenholme (2016) *Encyclopedia of Food and Health*, p. 298 ; The antioxidants in the process of ocular pathology. Fernández, et al. (2017) *Nutrition Hospital* 34 (2), p. 478 ; The action of avocado oil on the lipidogram of wistar rats submitted to prolonged androgenic stimulum . De Souza, et al. (2015). *Magazine Nutrition Hospital* (32) , p. 697; Avocado oil induces long-term alleviation of oxidative damage in kidney mitochondria from type 2 diabetic rats by improving glutathione status. Ortiz, et al. (2017) *Journal Bioenergy Biomembranes* , (49) p. 4 . Influence of the Modification of Eating Habits with the Inclusion of Avocado Oil on the Glycemic Control of Diabetic Patients in Tinajas, Colima, Mexico. Álvarez, et al. (2019). *Archives of Medicine* (15), p. 2 ; Nutritional and pharmaceutical benefits of avocado plant. Gupta, et al. (2018) *Journal of Advanced Scientific Research* , 9 (2) ; . Avocado: characteristics, health benefits and uses. Fonseca (2016) *Magazine Science Rural, Santa Maria*, 46 (4), p. 749 ; Effect of an avocado oil-enhanced diet (*Persea americana*) on sucrose-induced insulin resistance in Wistar rats. Del Toro, et al. (2016) *Journal of Food and Drug Analysis*, (24) , p. 351 ; Avocado Seed: A Comparative Study of Antioxidant Content and Capacity in Protecting Oil Models from Oxidation. Segovia , et al (2018) *Journal Molecules*. 23 (2421), p. 2 ; Yield, composition, and antioxidant activity of avocado pulp oil extracted by pressurized fluids. Abaidea et al., (2018). *Food and Bioproducts Processing* , (102), p. 291 ; Antioxidants in the process of ocular pathologies. Fernández, et al. (2017) *Hospital Nutrition* 34 (2), p. 478.

Avocado seed, includes the presence of condensed tannins , phenolic acids and flavonoids. The group of polyphenols include catechin, epicatechin and 3-

leucoanthocyanidins; recent studies have shown that the seed of this fruit has anti-inflammatory and anticancer properties (Segovia et al., 2018) .

Table 2. Health benefits of different parts of the avocado plant.

| Gupta, et al., (2018) | | Raya, et al., (2018) | García, et al., (2017) | Campuzano, et al., (2016) | Segovia, et al., (2018) |
|-------------------------------|--|--|------------------------|--|----------------------------------|
| Part of the fruit Leaf | Anti-inflammatory | NR | Bactericidal activity | NR | NR |
| | Analgesic | NR | NR | NR | NR |
| | Anticonvulsant | NR | NR | NR | NR |
| | Antidiabetic | NR | NR | NR | NR |
| | Hypocholesterolemic | NR | NR | NR | NR |
| | Relaxing vase | NR | NR | NR | NR |
| | Antiulcerant | NR | NR | NR | NR |
| Seed | Reduces VLDL | NR | NR | NR | Antioxidant |
| | Antidiarrheal | NR | NR | NR | Antimicrobial |
| | Osteoarthritis | NR | NR | NR | Anti-inflammatory |
| | Wound healing | NR | NR | NR | Anticancer |
| Pulp | Platelet aggregation inhibitor and prevents clot formation | Decreases nitric oxide levels and lipoperoxidation | NR | Decreases Total Cholesterol, LDL Triglycerides, VLDL, and raises HDL | Antioxidant |
| | Protection against cardiovascular diseases | | | | Antimicrobial |
| Oil | Improves and prevents type 1 diabetes | NR | NR | NR | Antithrombotic |
| | Liver regeneration | NR | NR | NR | Prevents against atherosclerosis |

*NR (Not reported).

Source: Adapted from Nutritional and pharmaceutical benefits of avocado plant, Gupta , et al.,2018 . *Journal of Advanced Scientific Research*, 9 (2), p. 8. Avocado inhibits oxidative stress and dysfunction Avocado inhibits oxidative stress and dysfunction, Raya, et al., (2018). *Journal of Internal Medicine*, 34 (6) p.844. García, et al., (2017). Inhibition of the expression of the

system agr. of *Staphylococcus aureus* resistant to methicillin using total polyphenol leaves Mexican avocado (*Persea americana* var. *Drymifolia*); *Revista Nova Scientia* 18 (8), p. 210. Campuzano, et al., 2016. Influence of consumption of avocado pulp, *Persea americana*, on lipid metabolism in diet-induced normolipemic and hyperlipemic mice, *Latin American Nutrition Archives*, 66 (4), p. 282.

It is mentioned that extra virgin avocado oil is also characterized by having a high content of $\omega 3$, $\omega 6$ and Vitamin E fatty acids, positioning this type of oil as a highly nutritious and potentially functional food (Yepes et al., 2017).

Under this premise the binomial nutrition and health, and this new food culture, the population now displays the fact that certain components, such as the antioxidants in many food products, are important because they can reduce the risk to develop various types of chronic diseases such as cancer. In the diet, avocado plays a very important role minimizing free radicals generated in various biochemical and physiological processes or by environmental factors avoiding alterations in cell regeneration of the tissues, also the prevention of chronic or degenerative diseases, due to its content of phytochemical compounds, including carotenoids, polyphenols and antioxidant vitamins, among others (Beltrán, 2016).

In recent years there had been numerous advances in science and technology, which have led to changing patterns of consumption, production and marketing, creating a strong interdependence whether local or global (Chin, 2019). With the COVID-19 pandemic, it is essential to change to an immediate vision of individual, family, regional and global eating habits that allow a deep analysis for strategic planning to face possible critical situations that may occur

in the near future (Pérez et al., 2020). With a holistic view of this situation, the actual pandemic includes major challenges for health systems around the world, proposing pragmatic protocols to propose nutritional changes for the world population. A conscious and responsible action is required to improve healthy eating schemes with high nutritional aspects (Álvarez et al., 2020).

Conclusions.

Food participates to assure a good health, since the amount and type of food consumed throughout life will modulate the activity of different cells, therefore the importance of consuming fresh food fruits, vegetables, whole grains, legumes, seeds and vegetables or fruits of different colours; in this sense, definitely Hass avocado represents an excellent alternative due to its high content of bioactive compounds.

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