

Anti-inflammatory foods: human food patterns, bioactive principles and mechanisms of action

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Abstract

With the increase in life expectancy accompanied by the gradual decrease in the birth rate as well as the greater income distribution associated with the quantitative increase in the minimum wage above inflation and the increase in its purchasing power, today the Brazilian population shows a moment exactly opposite to that found in the last century both in epidemiological terms and in the nutritional pattern. Brazil is currently experiencing the same pattern of mortality as developed countries: the majority of chronic non-communicable diseases are the main cause of death associated with an established model of obesity and sedentarism. These factors incline the scientific community and health professionals to turn their efforts to find food solutions that ease this epidemiological picture and it is in this context that anti-inflammatory foods have gained prominence. The following describes the main compounds that fit this magnitude of effect and their mechanisms of action.

Keywords: Anti-inflammatory foods; food patterns; human food.

1. Human food patterns and biological impact

With the advent of the industrial revolution, European society and, later, other continents, experienced a broad change not only in the mode of production – portrayed in a satirical and no less critical way in Charles Chaplin's "Modern Times" – but also experienced a transformation in the way we relate to time and, consequently, to our food.

The rural exodus, the emergence of megalopolis, the concentration of the labor force in isolated places in residential areas, and also the entry of women into the labor market has driven a growing demand for meals outside the home and not only this, but meals that fit into daily production.

In Brazil, the epidemiological portrait of the beginning of the last century to the middle of the 90's was made by a country whose great part of the deaths came from infectious diseases of etiology linked to social problems whose prophylaxis depended not only on a health service of immediate and individual action, but on political actions that demanded strong investments in several public sectors, among them basic sanitation and education.

Parallel to this, the nutritional pattern was composed of malnutrition at epidemic levels, a situation that was

further aggravated by analyzing more interior regions and regions of difficult geographic access, such as the northeastern sertão and certain Amazonian communities.

The recent economic advances that have driven Brazil to the position of developing country as well as the recent social and welfare achievements implemented in the country since the 1990s as well as its restructuring, institutionalization and normatization in the first decade of this century have provided the country with a profound change in the epidemiological and nutritional situation, a fact evidenced by the most recent data from population surveys that show a considerable increase in life expectancy, due to the improvement in the educational framework, drastic decrease in infant mortality and the incidence of malnutrition.

However, with the increase in life expectancy accompanied by the gradual decrease in the birth rate as well as the greater income distribution associated with the quantitative increase in the minimum wage above inflation and the increase in its purchasing power, today the Brazilian population shows a moment exactly opposite to that found in the last century both in epidemiological terms and in the nutritional pattern. Brazil is currently experiencing the same pattern of mortality as developed countries: the majority of chronic non-communicable diseases are the main cause of death associated with an established model of obesity and sedentarism.

2. Anti-inflammatory foods

These factors incline the scientific community and health professionals to turn their efforts to find food solutions that ease this epidemiological picture and it is in this context that anti-inflammatory foods have gained prominence. The following describes the main compounds that fit this magnitude of effect and their mechanisms of action.

Phytoalexins are compounds whose anti-inflammatory effect is well described in the scientific literature. Their main representative is resveratrol which can be found in its *cis* or *trans* form, the second being the most chemically stable and bioactive.

This compound inhibits the expression of pro-inflammatory cytokines in LPS-stimulated lung cells, suppresses activation of NF- κ B and AP-1 transcription factors, inhibits activation of JNK and its upstream protein MEK, and inhibits gene expression of COX-2 and iNOS enzymes and cell surface adhesion molecules ICAM-1, ELAM-1 and VCAM-1.

The main food source of resveratrol is *Vitis vinifera* and, consequently, the dry red wine; other grape varieties as well as derived products tend to present reduced amounts of this compound since its concentration in the fruit is largely related to the type of soil and climate of the planting region, which places Brazilian grapes as one of the varieties with the lowest concentration in resveratrol.

The presence of alcohol in the fermented beverage of *Vitis vinifera*, contrary to what you can imagine common sense, serves as a vehicle of absorption to this compound. However, one should be cautious and parsimony in the consumption since, nevertheless, alcoholism and its consequences are also one of the pathologies that cause most deaths in the world.

The latest studies estimate that 200mL of dry red wine daily presents significant reduction of inflammatory markers in the accumulation of 6 months in individuals with chronic non-communicable diseases and, on

the other hand, the cardioprotective benefit of this ingestion in the healthy population still remains an unknown.

Other two compounds that present known anti-inflammatory action are curcumin and catechins; the first is a phenolic pigment of yellowish tone that can be found in the plant *Curcuma longa* and in vitro tests have already indicated positive results for its antibacterial, antiviral, antifungal and even antitumoral action; already catechin is a flavonoid widely found in the plant *Camellia sinensis* from which the so popular green tea is made.

In common, these two compounds have the primary defense action in the plant and, again contrary to simplistic reasoning, are present in higher concentrations when originating from poor soils. This is due to the inversely proportional relationship between the bioavailability of soluble nitrogen contents in the soil and the concentration of defense compounds in the plant. The most common species in fertile soils tend to allocate carbon compounds for plant growth, thus decreasing the carbon/nutrient ratio, while plants from less fertile soils tend to drastically increase the synthesis of secondary defense compounds, becoming a more nutritionally attractive species at the biochemical level.

In in vitro studies curcumin has been shown to be able to modulate the expression of molecular targets including NF- κ B and consequently to modulate the transcription of COX-2, iNOS, VCAM-1, ICAM-1, TNF- α , IL-1, IL-6, IL-8, IL-12 and interferon- γ . In addition, it was able to sequester reactive oxygen species from TNF- κ B activation in the TNF- α -dependent step, as well as forbol-12-acetato-13-myristate (PMA) and hydrogen peroxide, and inhibited JNK activation in cells stimulated by TNF- α , ionizing radiation, PMA and UV-C.

Catechins in green tea inhibit the activation of the transcription factor NF- κ B while inhibiting the degradation of IKB- α induced by cell activation mediated by TNF- α , decrease the activity of the IKK protein involved in the phosphorylation of IKB- α and reduce both the gene expression of the enzyme COX-2 as well as the protein JNK and the transcription factor AP-1.

A typical raw extract of the rhizomes of the *Curcuma longa* plant contains about 70% to 76% curcumin, however there are no experimental or human studies predicting daily recommendations; studies in Asian populations – largest consumers of green tea in the world – have shown that the ingestion of 1.5Kg of *Camellia sinensis* leaf/year decreases the risk of prostate cancer by 99.91% and that regular daily consumption (min. 4x/week) is related to a lower prevalence of cognitive decline at advanced ages.

But perhaps, among the class of compounds whose anti-inflammatory action has already been described and substantiated by science, the most popular ones with the greatest diffusion in the media are the n-3 and n-6 polyunsaturated fatty acids: those commonly known as omega 3 and omega 6.

They are considered essential fatty acids, i.e., they are lipids that must be obtained by diet since the human body is not able to synthesize them naturally. This inability is due to the absence of the desaturase enzyme responsible for inserting a double bond between the C3-4 and C6-7 carbons in the terminal portion of the lipid chain; that is, although we physiologically produce the lipid precursors, our body is unable to convert them into omega-3 and omega-6, with a forced shutdown of the biochemical conversion chain in the lipid route.

There is no certain evolutionary explanation for this fact, but – in the field of anthropological hypotheses, perhaps it was this biological incapacity that “forced” the human species to seek greater variety in the basic

foods of its diet by increasing it with animal and vegetable proteins coming from the oceans, since today it is known that deepwater fish and algae are species endowed with the said enzyme absent in our body and, therefore, are the source of the fatty acids of the n-3 and n-6 family.

Speaking of source foods, the main representatives of omega 3 are the α -linolenic acid found mainly in seeds such as flaxseed and soya, and eicosapentaenoic acid whose main source is deepwater fish such as sardines, tuna and mackerel. Regarding omega 6, its main representatives are linoleic and arachidonic acids and, for both, the main food source are oilseeds and soy, corn and sunflower oils.

In the metabolic route of lipids in the human body the final biochemical compound of these fatty acids are called eicosanoids and they are responsible for the anti-inflammatory action. What is very little disclosed is the fact that not all eicosanoids will have action favorable to health, quite the contrary! In fact, omega-6-derived eicosanoids can, in fact, give rise to by-products – such as prostaglandins, leukotrienes, prostacyclins and thromboxanes – which are responsible for triggering and worsening the individual's inflammatory condition. Everything will depend on a key factor: the proportion existing between omega 3 and omega 6 in the diet.

This is due to the fact that there is a very specific pre-established concentration of the enzymes responsible for the process of conversion of these fatty acids in the human being and, depending on the ratio of them in the diet, the inflammatory route may be overactivated to the detriment of the synthesis of anti-inflammatory eicosanoids.

In biochemical terms, the adequate ratio recommended in the diet is in the range from 5:1 to a maximum of 10:1; that is, the limit for obtaining the beneficial effects of these fatty acids in the diet is the presence of 10 units of omega 6 for every 1 unit of omega 3. However, since soy oil is a source food of the n-6 family and is culturally consumed in excess by many individuals, studies indicate that the world average reaches values between 20:1 and alarming 32:1 in western populations, more than 3x plus the maximum recommended proportion.

From this comes the danger of supplementation in capsules of these fatty acids. Besides the fact that in our country, the legislation pertinent to the trade of these supplements is still in the process of consolidation, which opens dangerous market gaps for the sale of adulterated products, we can add the fact of the high consumption of soy oil; these factors contribute to an exacerbated consumption of omega 6 to the detriment of omega 3 which, as seen, will bring harmful effects instead of that desired by the individuals who consume them.

In fact, not only in relation to essential fatty acids, but also in relation to the other anti-inflammatory compounds described in this text, scientific nutritional studies indicate that considering bioavailability, absorption and effectiveness, the best way to consume these compounds is still the most natural possible: the food itself! The anti-inflammatory efficacy of omegas 3 and 6 present in fish such as sardines is almost 4x higher compared to the efficacy of the same compounds when ingested in food supplement capsules available on the market.

3. Competing Interests

The authors declare no competing interests.

4. References

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