IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Review Article
October 2016 Vol.:4, Issue:4

Production of Gallic acid-A Short Review

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

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Submission: 3 October 2016
Accepted: 10 October 2016
Published: 25 October 2016

Keywords: Gallic acid, trihydroxybenzoic acid, phenolic acid, 3,4,5-trihydroxybenzoic acid, gallate

ABSTRACT

Gallic acid is a trihydroxybenzoic acid, a type of phenolic acid, known as 3,4,5-trihydroxybenzoic acid also known as gallate. Literature survey reveals that fungal species of *A. niger* were extensively used by many workers for the production of Gallic acid.

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INTRODUCTION

Gallic acid is an organic acid found in a variety of foods and herbs that are well known as a powerful antioxidant. The chemical formula is $C_6H_2(OH)_3COOH$.

Gallic acid is found both free and as part of tannins. Salts and esters of gallic acid are termed gallates[1]. It does not contain gallium though its name gallic acid. It is an endogenous product found in plants. Gallic acid is one of the active compounds that have potent anti-angiogenic and alpha-glucosidase inhibitory activities.

Gallic acid is commonly used in the pharmaceutical industry because many *in vivo* and *in-vitro* studies in humans, animals, and cell culture have provided evidence for the following actions of gallic acid. It shows cytotoxicity against cancer cells. It can be used to treat albuminuria and diabetes. It seems to have antifungal and antiviral properties, used as an antioxidant and helps to protect human cells against oxidative damages. It can be used as a remote astringent in cases of internal hemorrhage used to treat psoriasis and external hemorrhoids containing gallic acid[3,4]. It is used in brewing industry and wine industry as clarifying agent and as flavoring agent in foods.

Pharmacological investigations have shown that this gallic acid has several biological activities such as antimicrobial, antifungal and antiviral, anti-inflammatory, antioxidant, anticarcinogenic and antimutagenic activities. Gallic acid is toxic to animals because of its reaction with DNA or proteoglycans.

Gallic is used in printing inks. Gallic acid is compound of interest to both pharmaceutical and chemical industries because of its several interesting properties and commercial applications[5]. Gallic acid is also found in gallnuts, sumav, witch hazel, watercress, oak bark, tea leaves, areca nut, bearberry (Arctostaphylos), blackberry, *Caesalpinia mimosoides*.

Properties

Pure gallic acid is a colorless crystalline organic powder, while salts and esters of gallic acid are termed gallate.

Physical and Chemical Properties[2]

Appearance: Fine crystals, white yellowish-white or pale, fawn-color.

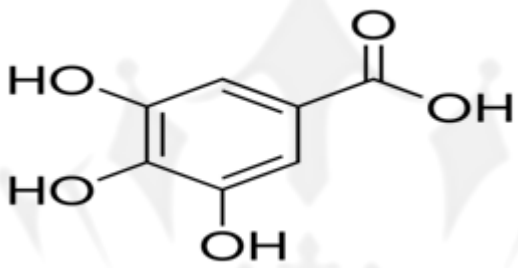
Odor: Odorless.

Solubility: 1.1g/100ml water @ 20^0C (68F) (anhydrous).

Density: 1.7 (anhydrous).

% Volatiles by volume @ 21C (70F): 1

Melting Point: 250^0C (482F).



Structure of Gallic acid

Uses of Gallic Acid

Ancient applications of Gallic acid:

Ancient cultures often believed in remedies and medicines that have later been moved to have ineffective. Foods and herbs rich in gallic acid usage in ancient cultures were not entirely inaccurate[5,6]. In actuality, these medicines and treatments often did work.

Past uses of Gallic acid:

Many of the foods containing Gallic acid have been used for years as natural remedies and were relied upon by various cultures for their medicinal properties. For example: Native Americans and early American settlers used the Blueberries to make an aromatic tea that was used as a relaxant during childbirth.

The list could continue for each of the foods where Gallic acid is present, for ancient cultures quickly learned of the beneficial properties of the plants and herbs that surrounded them, and many herbs and healthy foods contain Gallic acid[7,8]. The ancient cultures may not have understood the role of gallic acid even that gallic acid existed, in the foods and herbs they used for medicinal purposes. They did, however, believe that their medicines worked.

Modern uses of Gallic acid:

Gallic acid is believed to have health benefits to those at risk for certain forms of cancer or neural disorders. Studies have shown that neuronal death can be inhibited by gallic acid and it has anti-cancer properties against leukemia, certain prostate, colon and lung cancer cells[9,10]. Gallic acid has been shown to prevent cellular mutations and to be toxic to cancer cells while having no negative effect on healthy cells.

Gallic acid has antiviral and antifungal properties. It is a powerful antioxidant that helps to prevent oxidative damage[11,12,13]. Gallic acid also has therapeutic applications for inflammatory allergic diseases, such as asthma, allergic rhinitis, sinusitis due to its ability to inhibit histamine release and the expression of pro-inflammatory cytokine.

Clinical Pharmacology:

Gallic acid is a member of the family of chemicals called tannins. In much of literature, the tannins are taught to be responsible for the survival of higher plants over earlier less developed plant species. Gallic acid's role in those plants is significant as a pesticide. Digestibility of insects decreases which eat leaves containing tannins. Gallic acid has been beneficial in muscular skeleton problems, particularly low back pain. As with many phenolics, it benefits chronic fatigue.

A study was conducted on acidum gallicum tablets that contained 10% GA and 90% glucose and a black tea brew that contained 93% of its GA in free form to determine the pharmacokinetics and relative bioavailability of GA in healthy humans[14,15]. Concentrations of GA and its metabolite, 4-O-methylgallic acid (40MGA), were determined. GA from both the tablets and tea was rapidly absorbed and eliminated GA concentrations in the stomach could achieve a maximum of 1.5 mmol/L (there was 0.3 mol GA in 200ml tea brew) highest concentration observed in plasma[16,17].

GA has a duel role as antimelanogenic and antioxidative agents and effective compound for skin health. The putative effect of GA on the inhibition of skin tyrosinase and melanogenesis under *in vivo* conditions based our current *in vitro* data[18,19]. Gallic acid derived molecules can also act as plant growth promoters[20,21].

Forms of Gallic acid:

There are not supplements specifically of Gallic acid. However, there are plenty of readily available vitamins and nutritional supplements that contain Gallic acid and will help to give the benefits associated with Gallic acid. Most of these supplements are specifically designed to be rich antioxidants[22].

Some examples of pill from supplements that include Gallic acid are grape seed extract, rooibos tea extract, among others[23,24].

From natural juices, we can increase the intake of Gallic acid such as pomegranate, blueberry and grape juice, or through foods rich in Gallic acid[25].
Vitamins supplements containing gallic acid in pill form are available at local health stores. Prices vary depending on the brand purchased.

Side effects of Gallic acid:

Gallic acid has triggered contractile responses and inhibited the decrease of vascular pressure in the thoracic aorta. Gallic acid also interferes with the medications taken for high blood pressure or for heart problems[26]. Its use as an antioxidant helps to ensure overall and continued health and can be taken as a supplement to increase the levels of this beneficial antioxidant[27].

Table 1. Microorganisms and Raw materials used for the production of gallic acid

Sr. no	Name of the organism	Raw materials	Duration	Yield	Refer-ence	Year
1	*Aspergillus niger*	Tara fruit pods	Time/h :- 45.0	30%	33	1985
2	*Aspergillus* sps	Walnut	—	83.3%	44	1987
3	*Aspergillus niger*	Sumac leaves	Time/h:- 40.0	9.75%	34	1987
4	*Aspergillus niger*	Gall nut	Time/h:- 24.0	40.5%	35	1989
5	*Aspergillus* and *P. zan-cinthae*	Tara fruit pods	Time/h:- 30.0	30%	41	1990
6	*Rhizopus Oryzae (free cells)*	2% tannic acid in media	Time/h:- 96.0	83.5%	36	1997
7	*Rhizopus oryzae (im-mobilized cells)*	2% tannic acid in media	Time/h:- 96.0	78.5%	37	1997
8	*Aspergillus niger*	*Larrea tridentata*	—	39.4%	46	1997
9	*Rhizopus oryzae*	Teri pod cover	Time/h:- 72.0	90.90 %	30	1999
10	*Aspergillus fischer, As-pergillus niger and P. spinulosum*	*Quercus infectoria* gall nuts	—	91.3% 93.2%	43	2003
11	*Rhizopus oryzae*	Myrobalan and teri pod cover (mixed substrate)	Time/h:- 60.0	85.67 %	28	2004
12	*Aspergillus oryzae*	solid cashew husk	Time/h:- 48.0	0.14. %	29	2004
13	*Aspergillus foetides*	Myrobalan and teri pod cover (mixed substrate)	Time/h:- 72.0	90.48 %	38	2004
14	*Rhizopus oryzae and As-pergillus foetidus (co-culture)*	Myrobalan and teri pod cover (mixed substrate)	Time/h:- 48.0	94.8%	39	2005
15	*Aspergillus and P. zan-cinthae*	Tara fruit pods	—	46.1%	42	2005
16	*Aspergillus sps*	Walnut	—	96%	45	2005
17	*Aspergillus niger*	Solid	Time/h:- 43.0	15%	31	2007
18	*Aspergillus niger*	Terminalia	—	72%	32	2007

		chebula				
19	*Aspergillus awamori*	Tannase	—	25.28 1 ug/ml	40	2012
20	*Aspergillus niger*	*Mimusops elengi*	Time(days):6-12 Temp: 25-45^0 c pH: 4-9	46%	47	2015

RESULTS AND DISCUSSION

The data reveals that *A. niger* species is widely used for the production of Gallic acid and Walnuts were found to be the best source of production. Since Gallic acid is having several medicinal properties, there is lot of scope for tapping other cheap sources containing tannins.

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