

Title

- [1] Co-Fermentation of Stevia Plant Material with Grape Pomace to Produce Stevia-Enriched Grape Purée

Field of the Invention

- [2] Fermented grape pomace, which consists of skins, seeds, and stems, is rich in bioactive compounds such as polyphenols, fiber, vitamins, and antioxidants. These compounds are fermented (as described in US 11,866,679 B2). They offer health benefits and make pomace a valuable ingredient in various industries, particularly food, cosmetics, and animal feed.
- [3] There is a growing emphasis on transforming grape pomace from waste to a resource, aligning with global sustainability goals. Companies are focusing on developing high-value products from pomace, such as functional foods, dietary supplements, and natural antioxidants, which enhance the nutritional profile and shelf life of food products.
- [4] Innovative processes like solid-state fermentation, and enzymatic treatments are used to improve the functional properties of pomace-derived products but also make them more accessible for diverse applications.
- [5] The use of grape pomace in creating high-value products is becoming an attractive business model, offering new revenue streams for wineries.
- [6] Stevia is a natural sweetener derived from the leaves of *Stevia rebaudiana*, a plant native to South America. Its sweetness comes from compounds called steviol glycosides, which are 200-300 times sweeter than sugar but contain no calories.
- [7] Stevia is widely used as a sugar substitute in beverages, baked goods, dairy products, and confectionery. It appeals to consumers seeking low-calorie, low-carb, or diabetic-friendly options. Stevia also enhances sweetness without affecting blood sugar levels, making it a popular choice in health and wellness products.
- [8] Stevia, while a popular natural sweetener, has several limitations:
- [9] Bitter Aftertaste: Some steviol glycosides can leave a lingering bitterness or licorice-like aftertaste, especially at higher concentrations.

- [10] **Limited Solubility:** In certain food applications, stevia may not dissolve as well as sugar.
- [11] **Textural Challenges:** Unlike sugar, it lacks bulk, which can affect the texture and mouthfeel in baked goods.
- [12] **Heat Stability:** While generally heat-stable, its sweetness profile may alter slightly in high-heat cooking.
- [13] **Regulatory and Labeling Constraints:** Not all stevia extracts are approved globally, requiring careful compliance.
- [14] **Co-fermenting stevia with grape pomace** could address its limitations by leveraging the natural microbial processes of fermentation. Here's how:
- [15] **Masking Bitter Aftertaste:** Fermentation can modify steviol glycosides, reducing bitterness and enhancing the overall sweetness profile.
- [16] **Improving Solubility:** Microbial activity can break down certain stevia compounds, potentially increasing its solubility in liquids.
- [17] **Enhancing Texture:** The fermentation process may introduce natural polysaccharides or fibers from grape pomace, adding bulk and improving texture in food applications.
- [18] **Enhanced Flavor Profile:** Fermentation generates organic acids and aromatic compounds, complementing stevia's sweetness with complex flavors, reducing the need for sugar.
- [19] This synergy can result in a more functional, palatable sweetener for a wider range of food applications.

Definitions

- [20] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention pertains.
- [21] The use of the word "a" or "an" when used herein in conjunction with the term "comprising" may mean "one," but it is also consistent with the meaning of "one or more," "at least one" and "one or more than one."

- [22] With reference to a system or process of the present disclosure, the terms “comprising,” “having,” “including” and “containing,” and grammatical variations thereof, as used herein, are inclusive or open-ended and do not exclude additional, unrecited elements and/or method/process steps. The term “consisting essentially of” or “essentially consisting of” denote that additional elements and/or method/process steps may be present, but that these additions do not materially affect the manner in which the recited elements and/or method/process steps function. The term “consisting of” when used herein excludes the presence of additional elements and/or method steps. A system or process and any aspect thereof described herein as comprising certain elements and/or steps may also, in certain embodiments consist essentially of those elements and/or steps, and in other embodiments consist of those elements and/or steps, whether or not these embodiments are specifically referred to.
- [23] As used herein, the term “about” refers to an approximately +/-10% variation from a given value. It is to be understood that such a variation is always included in any given value provided herein, whether or not it is specifically referred to.
- [24] The recitation of ranges herein is intended to convey both the ranges and individual values falling within the ranges, to the same place value as the numerals used to denote the range, unless otherwise indicated herein.
- [25] The use of any examples or exemplary language, e.g., “such as”, “exemplary embodiment”, “illustrative embodiment” and “for example” is intended to illustrate or denote aspects, embodiments, variations, elements or features relating to the invention and not intended to limit the scope of the invention.

Summary of the Invention

- [26] The invention of co-fermenting grape pomace with stevia plants involves using microbial fermentation to improve the sensory and functional properties of both ingredients. Grape pomace provides antioxidants, polyphenols, and fiber, while fermentation reduces stevia's bitterness and enhances its sweetness profile. The process also improves solubility and texture, making the blend a versatile, natural sweetener with added health benefits. This innovation can be applied in functional foods, beverages, and health supplements, promoting sustainability by upcycling agricultural by-products.

Detailed Description of the Invention

- [27] Process for Co-Fermentation of Stevia and Grape Pomace **Fig.1**
- [28] Preparation of Raw Materials **[100]**
- [29] Grape Pomace: Collected fresh from the winemaking process, containing skins, seeds, and residual pulp. It is washed and milled to achieve a uniform consistency.
- [30] Stevia Leaves: Dried and finely ground to maximize surface area for microbial access and break down .
- [31] Pre-Fermentation Treatment **[101]**
- [32] Both materials may undergo mild enzymatic or heat treatment to release sugars and polyphenols, improving substrate availability for microbes.
- [33] In one embodiment, the mixture is treated with ozonated liquid to eliminate any wild microbes in the material.
- [34] In one embodiment, the mixture is washed 7 times with its equivalent weight in water, then is dried to less than 10% to meet the requirements of kosher certification.
- [35] Inoculation with Microbial Culture **[102]**
- [36] A mixed microbial starter culture containing yeast (*Saccharomyces cerevisiae*) and beneficial aerobic bacteria (*Acetobacter*, *Lactobacillus*) is introduced.
- [37] These microbes are selected for their ability to metabolize polyphenols and modify steviol glycosides to reduce bitterness.
- [38] Fermentation Conditions **[103]**
- [39] Oxygen Supply: Continuous aeration is provided to support aerobic fermentation, typically using an air diffuser or mechanical stirring system.
- [40] Temperature: Maintained between 10-40°C to optimize microbial growth and metabolic activity.
- [41] Duration: The process runs for 24 hours - 90 days, depending on desired flavor development and sweetness modification.
- [42] Biochemical Transformations **[104]**

- [43] Polyphenol Interaction: Polyphenols from grape pomace bind with steviol glycosides, reducing bitterness and creating a more balanced flavor profile.
- [44] Enzymatic Modifications: Microbial enzymes partially break down complex carbohydrates and release additional sweet compounds, improving texture and sweetness.
- [45] Production of Volatile Compounds: Organic acids and aromatic compounds are generated, enhancing the sensory properties of the final product.
- [46] Post-Fermentation Processing **[105]**
- [47] The product is ground so that particles are less than 50 micrometers.
- [48] The fermented purée is filtered and pasteurized (if needed),
- [49] The purée is dried into a powder or blended into a liquid concentrate for use as a natural sweetener or functional ingredient.
- [50] End Product **[106]**
- [51] The final product is a sweet, antioxidant-rich ingredient with improved solubility, reduced bitterness, and enhanced flavor, suitable for various food and beverage applications.
- [52] This co-fermentation process leverages the complementary properties of stevia and grape pomace, creating a multifunctional ingredient while supporting sustainable practices through waste valorization.

Claims

[53] Here are potential claims to include in a provisional patent for co-fermenting stevia and grape pomace:

1. Process Claim

- [54] A method for co-fermenting stevia leaves and grape pomace under aerobic conditions, comprising:
- [55] Preparing stevia leaves and grape pomace as fermentation substrates.
- [56] Inoculating with a microbial culture comprising yeast and aerobic bacteria.
- [57] Fermenting at a temperature between 10°C and 35°C with continuous aeration.
- [58] Harvesting a fermented product with reduced bitterness and enhanced sweetness.
- [59] The method of claim 1, wherein the fermentation duration is 24 hours - 90 days
- [60] The method of claim 1, further comprising enzymatic treatment of the substrates prior to fermentation to release sugars and polyphenols.

2. Product Claim

- [61] The method of claim 1, wherein the weight ratio of stevia to grape pomace is between 1:100 and 1:1000.
- [62] The method of claim 1, wherein the moisture content during fermentation is maintained between 50% and 90%.
- [63] In one embodiment, the purée is ground to produce particles no larger than 50 micrometers.
- [64] In one embodiment, the product is dried to less than 10% moisture and ground into fine powder.
- [65] A fermented sweetener product produced by the method of claim 1, comprising:
- [66] A synergistic combination of steviol glycosides and polyphenols.
- [67] Reduced bitterness compared to unfermented stevia.
- [68] Improved solubility and a smooth texture.
- [69] The fermented sweetener of claim 1, further comprising organic acids and aromatic compounds that enhance the flavor profile for food and beverage applications.

3. Use Claim

- [70] The fermented sweetener of claim 1 for use as a natural sweetener in beverages, baked goods, and functional foods.
- [71] The fermented sweetener of claim 1 for use in diabetic-friendly and low-calorie products.
- [72] These claims should emphasize the novelty of your process, the specific proportions, and the enhanced properties of the resulting product. Would you like help refining any of these further?

Prior Art

- [73] US 11,866,679 B2 describes a method for fermenting grape pomace to enhance nutritional properties. The process increases polyphenol bioavailability and improves sensory characteristics for use in functional foods.
- [74] Unlike the prior art, this invention co-ferments stevia with grape pomace, yielding a product enriched with healthy fats, fiber, and enhanced antioxidant synergy.
- [75] The distinct aspects are:
- [76] Unique Ingredients: Combination of raw stevia and grape pomace.
- [77] Product Characteristics:
- [78] The powder or paste has a sweet sensation, which is enhanced by both the steviol and the polyphenols
- [79] The powder or paste has unique texture that compensates for the bulk from the removed sugar
- [80] The powder or paste has as nutritional profile that provides a fresh sweet fruity taste.

Stevia fermentation

- [81] Here are the DOIs for the academic papers referenced in the discussion on stevia fermentation:
- [82] **US Patent Application No. 20210102229**
This patent describes methods for fermenting engineered yeast in a medium containing steviol glycosides. The yeast expresses specific enzymes, including glucosyltransferases, which catalyze the production of glycosides such as

Rebaudioside A, D, and M. The medium may contain starch-derived sugars or pre-treated plant materials to optimize microbial growth and enzymatic activity 【99†source】 .

[83] US Patent Application No. 20180020709

This invention focuses on α -glycosylation of steviol glycosides during fermentation. Transglucosylation enzymes are used to create glycoside derivatives with enhanced solubility and functionality. The patent highlights the application of recombinant microorganisms and enzymatic hydrolysis to produce derivatives suitable for broader food and beverage uses 【100†source】 .

[84] Exploration of Microbial Communities in Stevia Fermentation

[85] Title: "Human Health Benefits and Microbial Consortium of Stevia Fermented with Barley Nuruk" DOI: [10.3390/fermentation10070330](https://doi.org/10.3390/fermentation10070330) 【89†source】 .

[86] This process ferments stevia with a microbe known as Barley Nuruk

[87] Unlike the prior art, this invention co-ferments stevia with grape pomace, yielding a product enriched with healthy fats, fiber, and enhanced antioxidant synergy.

[88] Applications of Stevia Residue in Bioelectricity Production

[89] Title: "Stevia Fermentation and Microbial Fuel Cell Applications"

[90] Note: This paper doesn't have a direct DOI listed in the citation but can be accessed via ResearchGate 【88†source】 .

[91] Solid-State Fermentation of Stevia Residue with *Trichoderma guizhouense*

[92] Title: "Spore production in the solid-state fermentation of stevia residue by *Trichoderma guizhouense* and its effects on corn growth"

[93] DOI: This study may also need direct database access; no DOI was directly provided 【90†source】 .

[94] This process ferments stevia with a microbe known as *Trichoderma guizhouense*

[95] Unlike the prior art, this invention co-ferments stevia with grape pomace, yielding a product enriched with healthy fats, fiber, and enhanced antioxidant synergy.