



Eco-friendly, biodegradable chewing gum

Chewing gum is available in a wide variety of flavours such as mint, wintergreen, cinnamon and various types of fruits. Mintier flavours are often chewed for fresher breath. There is no standard type of gum, as it can be formed in many different shapes and sizes. Some examples include:



- *Gum balls* - shaped like a ball and coated. These are most often sold in gum ball machines.
- *Bubblegum* - formulated with film-forming characteristics for blowing bubbles.

Multi-coloured chewing gum balls

- *Sugarfree gum* - made with artificial sweeteners.
- *Candy & Gum combinations* - predominantly bubblegum found in the center of some types of lollipop, such as Charms Blow Pops.
- *Center-filled gum* - Pellet or ball gum formed around a soft or liquid centre.
- *Cut & Wrap gum* - refers to the name of the machine that wraps this type of gum, usually in the form of a chunk, cube or cylindrical shape.
- *Dragée gum or "pellet gum"* - a pillow-shaped coated pellet, often packed in blister packs.
- *Functional gum* - a chewing gum with a practical function. Vibe Energy Gum, for example, uses gum as the delivery system for Caffeine, Ginseng, Guarana and Green Tea.
- *Medicated gum* - a chewing gum acting as a delivery system to introduce medicinal substances into the saliva and thus into the bloodstream faster than pills.
- *Powdered gum* - free-flowing powder form or powders compressed into unique shapes.
- *Stick gum* - a rectangular, thin, flat, slab of gum.
- *Ribbon gum or tape gum* - very similar to stick gum in shape, but much longer, coiled up in a cylindrical container often shaped like a hockey puck. The chewer tears off a piece of the desired size.
- *Tube gum or spaghetti gum* - very soft bubble gum which can be squeezed from a tube or can be found in a pouch.

Conventional chewing gum products are not “environment-friendly.” They can maintain stickiness during and after chewing and adhere to the ground, if care is not taken with regard to disposal of the gum product. The stickiness of such conventional chewing gum products results, in large part, from the use of elastomer solvents (i.e., resins) and other “tacky” ingredients (such as wax) during the manufacturing process. In particular, conventional chewing gums manufactured using elastomer solvents exhibit a continuous or substantially continuous phase

when chewed. As the continuous phase is characterized by an amorphous elastomer matrix containing sticky elastomer solvents, the gum bolus that results upon chewing also is sticky.

Moreover, although gum products that allegedly do not stick to teeth and oral prosthetics during mastication are reported, there nevertheless remains a need for chewing gum products that also exhibit reduced stickiness or non-stick properties upon disposal of the gum product subsequent to chewing. In particular, there remains a need for environment-friendly chewing gum boluses that exhibit reduced stickiness to, or do not stick to, those surfaces where gum boluses that are improperly disposed of are often found (e.g., pavement, shoes, hair, undersides of tables and desks).

Descriptions

The reduced or non-stick properties are achieved by employing certain fats and/or oils which soften the elastomers in chewing gum without causing excess stickiness. Other steps of the process relate to rendering chewing gum compositions biodegradable. Biodegradability is enhanced by incorporation of free-radical generators, such as photosensitizers.

Desirably, the non-stick inducing components have a number of advantages, including facilitating the softening of solid elastomer components in the production of gum base as well as preventing or reducing the tendency of chewing gum compositions and products made there from sticking to surfaces such as packages, teeth, oral prosthetics such as implants and dentures, as well as to concrete, stone, plastic, wood, pavement, brick, glass and various other similar surfaces. The non-stick inducing components may be any components that cause the final T_g of an elastomer used in a chewing gum composition to change no more than about three degrees (3°), up or down from the initial T_g during processing. The non-stick inducing components that serve as a release agent, crystallize or form domain regions in the gum base elastomers and have a hydrophobic portion and a hydrophilic portion, wherein the hydrophobic portion is capable of orienting inwardly within a gum bolus and the hydrophilic portion is capable of orienting outwardly within a gum bolus.

The non-stick inducing components may contribute to one or more of the following advantages:

- (i) Facilitate the process of converting a solid or solid-like elastomer into some other form, such as a homogenous or substantially homogenous softened or malleable mass;
- (ii) Allow sufficient softening for processing and for use in a chewing gum product; and
- (iii) Provide softening without an increase in stickiness of the final gum product.

The non-stick inducing components have been found to exhibit various physical properties including the ability to migrate to the surface of the chewing gum product to create a release barrier which reduces the ability of the chewing gum product from sticking to surfaces.

It has also been discovered, that the addition of methyl ester liquid rosin, desirably in low amounts, may be advantageously employed to enhance softening without contributing to stickiness.

In other steps of the process, the chewing gum compositions may be rendered more environment friendly by the incorporation of additional components which enhance the degradation of the chewing gum, such that it loses its ability to maintain its cohesiveness and crumbles and breaks apart into smaller, discontinuous pieces over time.

Desirably, the non-stick inducing component(s) provide(s) a maximum change in glass transition temperature of an elastomer of about $\pm 3^\circ$ when brought into contact with an elastomer (e.g., by mixing) during manufacture of a chewing gum base and provide a surface barrier. Desirably, the surface barrier has release properties such that a gum bolus formed upon chewing exhibits a reduced adherence to a variety of surfaces as compared to gum compositions not containing the non-stick inducing component.

More particularly, non-stick inducing components may include, without limitation, the following: various fats and oils including saturated and unsaturated fatty acids having a carbon chain length of C₁₄ to C₂₄; including for example saturated and unsaturated fatty acids such as stearic acid, oleic acid, palmitic acid, linoleic acid, arachidonic acid, myristic acid, palmitoleic acid.

The ratio of non-stick inducing component to elastomer (non-stick: elastomer) may be in the range of about 1:1 to about 10:1 and desirably in the range of about 4:1 to about 8:1. When optional components such as elastomer solvents or waxes are employed along with the non-stick inducing component, the ratio of non-stick inducing component to elastomer solvent (non-stick solvent or wax) may be about 1:0 to about 4:1.

More particularly, the present process gum bases may include at least one fat having a melting point of about 70° C and at least one fat having a melting point of about 40° C. The non-stick inducing component may be present in amounts of about 10% to about 60% by weight of the chewing gum base.

The elastomers (rubbers) employed in the gum base will vary greatly depending upon various factors such as the type of gum base desired, the consistency of gum composition desired and the other components used in the composition to make the final chewing gum product. The elastomer may be any water-insoluble polymer. Specific examples of elastomers include polyisobutylene, styrene butadiene rubber, butyl rubber, and combinations thereof.

Additional useful polymers include: polybutylmethacrylate/acrylic acid copolymers, polyvinylacetate/vinylalcohol copolymers, microcrystalline cellulose, sodium carboxymethyl cellulose, hydroxypropylmethyl cellulose and many others. In general, the elastomer employed in the gum base may have an average molecular weight of at least about 200,000. Desirably, the elastomer employed in the gum base has an average molecular weight from about 200,000 to about 2,000,000.

The chewing gum base may include a texture-modifier. In general, the texture-modifier has a molecular weight of at least about 2,000, comprises a vinyl polymer include, for example, polyvinyl acetate, polyvinyl laurate acetate, polyvinyl alcohol or mixtures thereof. The texture-modifier is present in an amount from about 30% to about 45% by weight of the gum base.

The gum base may also contain less than conventional amounts of elastomer solvents to aid in softening the elastomer, for example, terpinene resins such as polymers of alpha-pinene or beta-pinene, methyl, glycerol and pentaerythritol esters of rosins and modified rosins.

The elastomer solvent may be employed in the gum base in less than conventional amounts, for example, amounts from about 0.1% to about 3.0%, by weight, of the gum base. The gum base is free of added elastomer solvent and also free of added waxes.

The gum base also may include emulsifiers which aid in dispersing the immiscible components of the gum base into a single stable system, include glyceryl monostearate, lecithin, fatty acid monoglycerides, diglycerides, propylene glycol monostearate, and the like, and mixtures thereof. The emulsifier may be employed in amounts from about 2% to about 7%, by weight, of the gum base.

The gum base may also include plasticizers or softeners to provide a variety of desirable textures and consistency properties, include triacetin (glyceryl triacetate), lanolin, palmitic acid, oleic acid, stearic acid, sodium stearate, potassium stearate, glyceryl lecithin, glyceryl monostearate, p waxes, and the like. The aforementioned plasticizers and softeners are generally employed in the gum base in amounts from about 2% to about 12%, by weight of the gum base.

Suitable waxes include for example, natural and synthetic waxes, petroleum waxes such as polyurethane waxes, polyethylene waxes, paraffin waxes, microcrystalline waxes, and fatty waxes and, more desirably, are present in an amount from about 3% to about 8% by weight of the gum base.

Anhydrous glycerin also may be employed as a softening agent.

The gum base also may include effective amounts of bulking agents such as mineral adjuvants which may serve as fillers and textural agents include calcium carbonate, magnesium carbonate, alumina, aluminum hydroxide, aluminum silicate, talc, calcium sulfate and their mixtures. These fillers or adjuvants may be used in the gum base compositions in various amounts. The filler may be present in an amount from about 3% to about 11%, by weight, of the gum base.

The gum base also may include at least one hydrophilic, water-absorbing polymer to help reduce the stickiness of the gum base. Suitable hydrophilic, water-absorbing polymers include the following: native and modified starches; chemically modified cellulose, including methyl cellulose, ethyl cellulose, carboxymethyl cellulose, hydroxypropyl cellulose; gums including xanthan gum, carageenan gum, guar gum, gum arabic, locust bean gum, curdlan, arabinoxylan, agara, and alginate; and pectin and gelatin.

Any agent that is capable of degrading an elastomer may be incorporated in various chewing gum composition steps. Desirably, the agent is lipophilic and serves to enhance the degradation of the gum product in the presence of light, i.e., photodegradation. A particularly useful agent that is capable of enhancing the elastomer degradation in the presence of light is chlorophyll and derivatives. Chlorophyll and its derivatives are capable of absorbing light and generating free radicals. The presence of free radicals may react with elastomer components to render them less sticky. Other suitable components to enhance degradation include other photosensitizers such as phthalocyanine derivatives, riboflavin, hemoglobin, myoglobin, and heme.

Encapsulation may be desirable to prevent premature degradation of the chewing gum base prior to mastication. Suitable encapsulants include, but are not limited to, fats, polymers, carbohydrates and combinations thereof. A particularly suitable encapsulant is gum arabic.

The agent capable of degrading an elastomer is present in a coating of the chewing gum composition. For example, such coatings are used on sugarless tablet gums to provide crunchiness as well as flavor, sweetness and sensate perception. In such compositions, the agent may be encapsulated or non-encapsulated. Most desirably, at least one agent capable of degrading an elastomer is present in an amount from about 0.07% to about 0.12% by weight of the gum base.

At least one antioxidant may be present in the chewing gum bases. Desirably, the antioxidant is water-soluble, include, for example, butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), propyl gallate, vitamin C, vitamin E and mixtures thereof. An antioxidant is included in the gum base, the antioxidant is generally present in an amount from about 0.01% by weight to about 0.3% by weight of the gum base.

Gum boluses of the present method will not stick to, or will have reduced stickiness, to a variety of surfaces external to the oral cavity, including, for example, asphalt, bricks, wood, plastic, hair, skin, carpeting, and the soles of shoes, as compared to gum boluses not having the formulations of the gum boluses of the present process.

Water-soluble sweeteners, water-soluble artificial sweeteners, water-soluble sweeteners derived from naturally occurring water-soluble sweeteners may be used. In general, a sweetener is present in amounts more specifically, from about 0.01% to about 2.0% by weight of the chewing gum composition.

The chewing gum compositions also may include a flavor agent, include spearmint oil, cinnamon oil, oil of wintergreen (methyl salicylate), peppermint oil, clove oil, bay oil, anise oil, eucalyptus oil, thyme oil, cedar leaf oil, oil of nutmeg, allspice, oil of sage, mace, oil of bitter almonds, and cassia oil. Useful flavorings are artificial, natural and synthetic fruit flavors such as vanilla, and citrus oils including lemon, orange, lime, grapefruit, and fruit essences including apple, pear, peach, grape, strawberry, raspberry, cherry, plum, pineapple, apricot and so forth. Other useful flavorings include aldehydes and esters.

A variety of other traditional ingredients also may be included in the chewing gum products in effective amounts such as colouring agents, antioxidants, preservatives. The colouring agents may include pigments which may be incorporated in amounts up to about 6%, by weight of the composition. For example, titanium dioxide may be incorporated in amounts up to about 2%, and preferably less than about 1%, by weight of the composition. Additional additives, such as sensates including physiological cooling agents; warming agents and tingling agents; throat-soothing agents; spices; herbs and herbal extracts, tooth-whitening agents; breath-freshening agents; vitamins and minerals; bioactive agents; caffeine; nicotine; drugs and other actives may also be included in any or all portions or regions of the chewing gum products. Among the useful cooling agents are included menthol, xylitol, erythritol. Cooling agents are generally present in amount of 0.01% to about 10.0%.

Warming agents may be selected from a wide variety of compounds known to provide the sensory signal of warming to the individual user. These compounds offer the perceived sensation of warmth, particularly in the oral cavity, and often enhance the perception of flavors,

sweeteners and other organoleptic components. Useful warming agents include those having at least one allyl vinyl component, which may bind to oral receptors. Examples of suitable warming agents include: vanillyl alcohol n-butylether; vanillyl alcohol n-propylether; vanillyl alcohol isopropylether. Tingling agents may provide a tingling, stinging or numbing sensation to the user. Tingling agents include: black pepper extract (piper nigrum) and red pepper oleoresin.

The sensation of warming or cooling effects may be prolonged with the use of a hydrophobic sweetener. Perillartine may also be added.

Breath freshening agents, in addition to the flavors and cooling agents described as above, may include a variety of compositions with odor controlling properties. Such breath freshening agents may include, cyclodextrin and magnolia bark extract.

A variety of oral care products also may be included in some steps of the instant chewing gum compositions. Such oral care products may include tooth whiteners, stain removers and anticalculus agents. Examples of these include, but are not limited to hydrolytic agents including proteolytic enzymes, abrasives such as hydrated silica, calcium carbonate, sodium bicarbonate and alumina. A variety of drugs, including medications, herbs, and nutritional supplements may also be included in the chewing gum compositions.

The chewing gum compositions of the present process may be formed into a variety of shapes and sizes and may take various product forms, including without limitation, sticks, slabs, chunks, balls, pillows, tablet, pellet, center-filled, pressed tablet, as well as coated and uncoated forms.

When the chewing gum compositions are formed into coated products, the coating may be applied by any method known. The outer coating may be hard or crunchy. The outer coating may also contain small amounts of water and gum arabic. The coating can be further coated with wax.

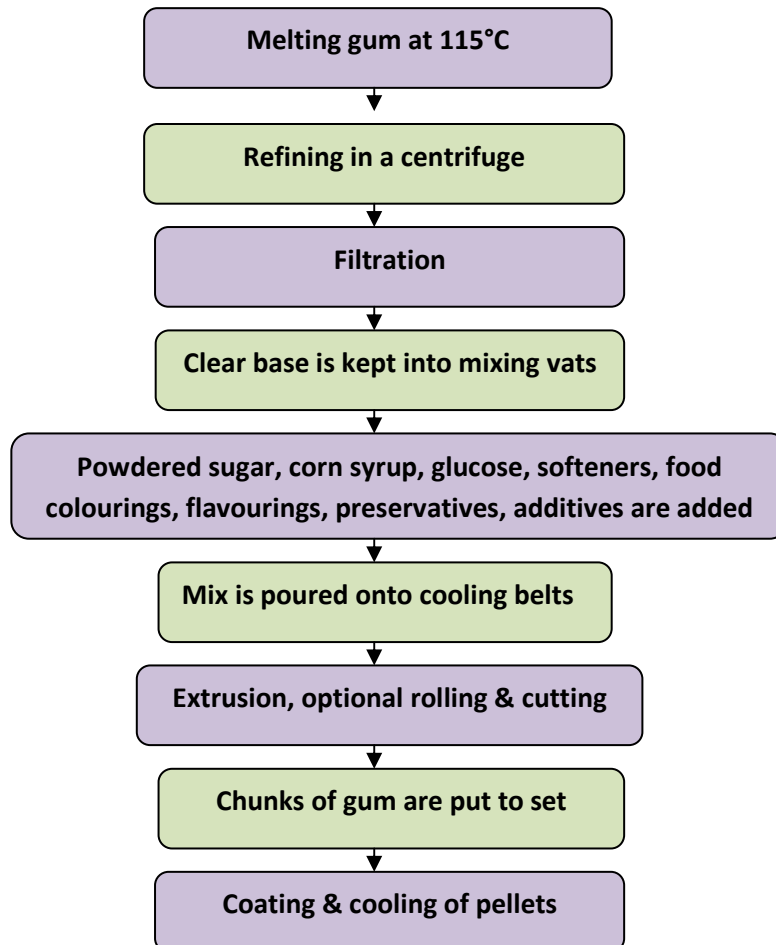
Manufacturing Process

The approximate manufacturing methods are fairly constant between brands. The gum base is melted at a temperature of about 115° c (240 °F), until it has the viscosity of thick maple syrup, then filtered through a fine mesh screen. Then it is further refined by separating dissolved particles in a centrifuge, and further filtered. Clear base, still hot and melted, is then put into mixing vats. Other ingredients that may be added include: powdered sugar (the amount and grain size of which determines the brittleness of the resulting gum), corn syrup and/or glucose (which serve as humectants and coat the sugar particles to stabilize their suspension and keep the gum flexible), various softeners, food colourings, flavourings, preservatives and other additives.

The homogenized mixture is then poured onto cooling belts and cooled with cold air. Extrusion, optional rolling and cutting, and other mechanical shaping operations follow. The chunks of gum are then put aside to set for 24 to 48 hours.

Coated chewing gums then undergo other operations. The chunks are wrapped with optional undercoating for better binding with outer layers then are immersed into liquid sugar. The pellets are then coloured and coated with a suitable glazing agent, usually a wax. The coating/glazing/colour on gum is sometimes derived from animal-based sources such as resinous glaze derived from an insect or beeswax.

While gum was historically sweetened with cane sugar, xylitol, corn syrup or other natural sweeteners, a large number of brands now use artificial sweeteners such as aspartame, sucralose, or Acesulfame potassium. Non-coated varieties of gum are often covered in sweetened marble dust to prevent the wrapper from sticking to the product.



Use in military

The United States military have regularly supplied soldiers with chewing gum since World War I because it helped to improve the soldiers' concentration. Recently, the U.S. armed forces have been providing troops with caffeinated gum to keep soldiers alert for extended periods of time without experiencing fatigue or drowsiness. Each stick of gum has approximately 100 mg of caffeine in it, about the same amount in an average cup of coffee. Although chewing gum is provided in the U.S. military MREs, it is often strongly discouraged for a troop to be seen chewing gum while standing in formation. The military uses different brands of chewing gum filled with caffeine like "Stay Alert."



CHEWING GUM CUTTING MACHINE

Effects on health

Dental health

Sugar-free gum sweetened with xylitol has been shown to reduce cavities and plaque by starving microorganisms in the mouth. The addition of calcium lactate has been shown to increase recalcification.

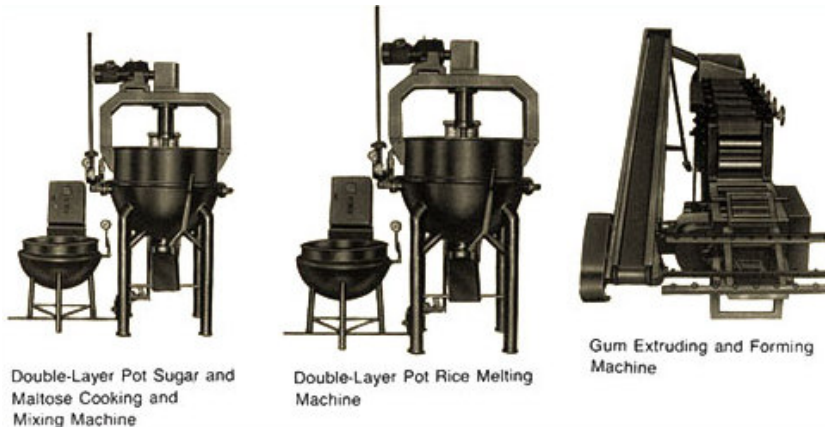
List of Machineries and their source of supply

- Blender
- Mixer with stirrer, temperature indicator, pressure gauze, inert Gas inlet connection
- Extruder
- Molding Machine
- Cooling Cabinet
- Sugar Coating Machine
- Wrapping Machine
- Double Colour Gum Machine

Latini Enterprises 4134 Gulf of Maxico Suite-207 Longboat Key, Fl.34228 USA	Garg Engineering Works B/188 Ashok Nagar Gali No-7 Sukar Bazar Chowk Mandoli Road, Shadaa -110093 Delhi- 9811185005	Kunj Kishore Industries 11-A Rajendra Nagar Industrial Area Mohan Nagar-201007 Gaziabad -9811032155
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Techno-Economics

Plant Capacity	400 kg/day
Working Capital	Rs. 15.0 Lacs
Plant & Machinery	Rs. 12.4 Lacs
T.C.I	Rs. 40.6 Lacs
Break Even	51.24 %
Return	47.01 %



Double-Layer Pot Sugar and Maltose Cooking and Mixing Machine



Double-Layer Pot Rice Melting Machine



Gum Extruding and Forming Machine



Universal High Speed Crushing Machine



Gum Melting Machine



Steam Melting and Mixing Machine

✍ **Dr Rakhshinda Panda,**
 ✍ Dr Himadri Panda,
 ✍ Kavita Prakash* and
 ✍ Arundhati Panda**

Devashish Consultants (P) Ltd
 61, West End City, Bidholia
 Rampur Road, P.O.; Clutterbuckganj
 Bareilly (U.P.) INDIA
 E.Mail: daffodil.bareilly.2008@gmail.com
 *Head, Dept. of Chemistry, Sainik School, Tilaiya, P.O. Tilaiya Dam, Koderma (Jharkhand)
 **ICFAI, Bareilly

Note: The author may have used various references in the preparation of this article. For further details please contact him/her.

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