Basic Formulas for the Use

of

STEVIA NATURAL SWEETENER

in Foodstuffs

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Excerpt of a Food Technology Study

5. General recommendations on foodstuff sweetening

Stevia Natural Sweetener is recommended for use in:

Foodstuff Group	Recommended Quantity(mg/kg) per kg ready prepared foodstuff
Sugar free water based flavoured drinks	160 - 700 mg/kg
Sugar free dairy based drinks	500 - 700 mg/kg
Sugar free fruit juice based drinks	300 - 700 mg/kg
Sugar free water based desserts	500 - 1000 mg/kg
Sugar free dairy based desserts	500 - 1000 mg/kg
Sugar free fruit juice based desserts	350 - 1000 mg/kg
Sugar free egg based desserts	500 - 1000 mg/kg
Sugar free cereal based desserts	500 - 1000 mg/kg
Sugar free fat based desserts	500 - 1000 mg/kg
Breakfast cereals	600 - 1000 mg/kg
Sugar free edible ices	500 - 800 mg/kg
Sugar free canned or bottled fruit	350 - 1000 mg/kg
Energy reduced jams, jellies, marmalades	500 - 2000 mg/kg
Energy reduced fruit preperations	300 - 1000 mg/kg
Sweet sour preserves of fruit	300 - 500 mg/kg
Sugar free confectionery	1000 - 3000 mg/kg
Sugar free cocoa or nut based confectionery	500 - 700 mg/kg
Sugar free starch based confectionery	500 - 2000 mg/kg
Sandwich spreads	500 - 1000 mg/kg
Sugar free chewing gum	700 - 5500 mg/kg
Fine bakery wares	500 - 2000 mg/kg
Sweet sour preserves and marinades of fish, crustaceans and molluscs	200 - 400 mg/kg
Sweet sour vegetables preserves	200 - 500 mg/kg
Sauces	350 - 500 mg/kg
Mustard	300 - 500 mg/kg
Salads prepared with sauces	350 - 500 mg/kg
Formulae for weight control intended to replace total daily food intake or an individual meal	300 - 800 mg/kg
Complete formulae and nutritional supplements for use under medical control	300 - 1000 mg/kg
Solid dietary supplements	300 - 2000 mg/kg
Liquid dietary supplements	300 - 600 mg/kg
Medicine preperations	1000 - 5000 mg/kg
Oral hygienic products	500 - 5000 mg/kg

6. Basic formulas for soft drinks

Low-calorie foods are usually analogues with half the calories of the more fattening regular products. Soft drinks are unique in that their low-calorie versions have almost no calories at all. Since their are no problems of bulk and texture they can be made by simply substituting the sugar by an intense sweetener. This allows the manufacturers to make such eye-catching claims as " Only 1 calorie per bottle". They are easily made, the sugar is removed from the formulation and replaced by an intense sweetener.

Below, formulations of different type of soft drinks are listed.

6.1. Sugar free water based flavored drinks

In many countries this type of drink is called "lemonade". This is the well-known clear, mostly colourless drink, without fruit juice, only flavored normally with lemon, orange or extracts of cola nut. The below formulas are typical formulas and do not represent any particular brand.

6.1.1. Lemon Lemonade

The lemonade is acidified to pH 2,6 with citric acid, the lemon flavoring is an alcoholic extract of essential oil of lemon and the three volumes of carbon dioxide are sufficent to preserve it from growth of yeast or mould, as well as providing the attractive sparkle. In some countries aseptic production and bottling is very difficult, use of a preservative aid is recommended. Through the absence of sugar the soft drink has only a low osmotic power and is more liable to spoilage so it must be preserved not only with carbon dioxide but with some preservative as well. Bacteriological principles say that if you must use preservative then you must always use an adequate amount so this recipe has 150 mg/litre. The calorie content is about 0,2 kcal per 100 ml.

Ingredient	Unit	Quantity
Stevia	kg/100 litre	0,07
Citric acid	kg/100 litre	0,22
Lemon flavoring	kg/100 litre	al gusto
Preservative	kg/100 litre	0,015
Carbon dioxide volume	Volume/100 litre	3,0

6.1.2 Low-calorie lemonade with sugar like viscosity

To give a low-calorie lemonade a sugar like viscosity it is necassary to improve the above given recipe. A soft drink sweetend with sucrose has approximately a sugar concentration between 9 to 12 %. This is corresponding to a specific gravity of 1,043 and a viscosity of 1,80 cP. Through the absence of sugar the specific gravity and the viscosity is decreasing. Sucrose itself contribute to correct the factors related to texture. To produce a low-calorie soft drink, bulking agents other than sucrose should be used. Polymeric carbohydrates like polydextrose, Lycasin, inulin or hydrocolloids like pectin, carrageenan or arabic gum are suitable as dietary bulking agent. They are low-calorie, non-cariogenic and water soluble. Their increased viscosity allows the use of small amounts of these products to acieve the desired texture for the diet beverage. They may also be used to stabilise flavors.
In the below described formula Polydextrose is used to increase the viscosity at a level of 3%. For high viscosity soft drinks a level up to 5% is recommended. Polydextrose is only slightly degraded in the colon and its caloric value is estimated to be 1 kcal/g. The below recipe serve with 3,2 kcal/100 ml.

Ingredient	**Unit**	**Quantity**
Stevia	kg/100 litre	0,07
Citric acid	kg/100 litre	0,22
Polydextrose	kg/100 litre	3,00
Flavoring	kg/100 litre	al gusto
Preservative	kg/100 litre	0,015
Carbon dioxide volume	Volume/100 litre	3,00

6.1.3 Low-calorie lemonade with a sugar like mouthfeeling effect

To improve not only the viscosity but also the mouthfeeling effect, the natural ingredient pectin can be used in the place of the synthetically produced polydextrose.

Ingredient	**Unit**	**Quantity**
Stevia	kg/100 litre	0,07
Citric acid	kg/100 litre	0,22
Flavoring	kg/100 litre	al gusto
Pectin	kg/100 litre	0,15
Perservative	kg/100 litre	0,015
Carbon dioxide volume	Volume/100 litre	3,00

6.1.4 Cola soft drink

The most consumed lemonade world wide is a cola soft drink. For the final production of the finished soft drink a cola concentrate is mixed with water and carbon dioxide directly before bottling. The full cola recipe is given below in all steps.

Ingredient	Unit	Quantity
Stevia Natural Sweetener	kg/l	0,07
Cola flavor base	ml/l	108,5
Phosphoric acid, 85%	ml/l	8,5
Caramel, acid proof	kg/l	0,007
Salt solution	ml/l	6,0
Citric acid solution, 50%	ml/l	5,0
Processed water	ml/l	872,0

For the preparation of the cola flavor base following ingredients are used:

Ingredients	Unit	Quantity
Vanilla extract *	gr/l	1,32
Solid extract Kola nuts *	gr/l	4,29
Caffeine	gr/l	21,94
Lime oil extract	gr/l	25,00
Cola flavor emulsion	gr/l	41,74
Phosphoric acid, 85%	gr/l	75,56
Caramel, acid proof	gr/l	158,52
Processed water	gr/l	671,63

* = special recipes for extract preparation are available

To prepare the cola flavor emulsion following ingredients are used:

Ingredients	Unit	Quantity
Orange oil emulsion*	gr/l	119,94
Arabic gum	gr/l	89,82
Oil of cinnamon	gr/l	13,21
Oil of lemon, cold pressed	gr/l	6,60
Oil of lime, destilled	gr/l	2,64
Oil of orange, cold pressed	gr/l	2,64
Oil of coriander	gr/l	1,32
Processed water	gr/l	763,83

* = special recipe is available

The preparation of the cola flavor emulsion needs a special procedure, described below:

a) Combine essential oils, add magnesium carbonate and filter.

b) Prepare orange oil emulsion and arabic gum emulsion by heating first the oil up to 60°C for 0,5 hours. Take off heater and add to the heated oil slowly the arabic gum. Keep this solution for another 15 min agitating.

c) To the mixture add slowly first the essential oils of a), then the water and keep agitating for another 15 min.

d) Homogenize the mixture of c) at 211 kg/cm².

6.1.5 Beverage powder mix

For the formulation of a beverage powder mix a combination of fructose and stevia natural sweetener can be utilised:
a) Increased sweetness compared with sucrose
b) Rapid solubility in cold water
c) Flavor accentuation of fruit, citrus and berry flavors

To prepare the beverage powder mix following ingredients are used:

Ingredient	**Quantity**
Crystalline fructose	21,140 kg
Anhydrous citric acid	2,190 kg
Ascorbic acid	0,167 kg
Carrageenan gum	0,038 kg
Riboflavin	0,006 kg
Silicon dioxide	0,119 kg
Clouding agent	0,076 kg
Lemon flavor	0,126 kg
Stevia	0,143 kg

Use the beverage powder mix wit a rate of 40 gram for one liter cold water.

Production process:
a) Pre-mix all ingredients except fructose and silicon dioxide

b) Pre-mix fructose and silicon dioxide

c) Mix stages a) and b)

Manufacture and packing should be conducted at a relative humidity below 60% and a temperature below 25°C.

6.2 Sugar free fruit juice based drinks

It is difficult to replace sugar in fruit juice based drinks without altering their quality of taste, flavor and ease of processing. In the formulation of a fruit juice based drinks, the balance between sweetness and sourness is critically important, from the taste profil point of view. The other noticeable difference is the reduced amounts of soluble solids as compared to sucrose, resulting in lower viscosity and altering mouthfeel. In sugarless low-calorie fruit based beverages, such viscosity enhancers as food gums or pectins are suitable to stabilise the flavor, especially when low-densitity essential oil are incorporated into flavor emulsions to correct palatability.
Through correct choice of fruit juice concentrates with high pectin content and low flavonoid content is it possible to produce a sugar like low-calorie fruit juice based beverage with Stevia as only sweetening source.
The known Maillard reaction is lowered to a minimum through the absence of sucrose or other nutrive carbohydrates.

A laboratory test should be done always with the same fruit juice concentrates stored under equal conditions. The qualitative sensoric changes during storage is able to have a strong affect on organoleptic perception. It is necessary to consider following means by creation of a low-calorie fruit juice based beverage sweetend with Stevia:

a) Attention with the choice of the fruit concentrates (origin, pectin content, pulp portion). For a Stevia sweetend orange juice lemonade for example is best to use concentrates with a high portion of brasil origin and with low or better no portion of european oranges, because of their high flavonoid content. Pulp portion can be high, also a high pectin content is recommended.

b) Good aromas (mixture of different aromas, terpen content). To use with stevia a low terpen content is recommended and if allowed according food law, a portion of peel oil also.

c) Addition of ascorbic acid for inhibition of oxidation.

d) Addition of cloud stabilizers as pectins or alginates providing permitted by food law.

Following addition of Stevia to different fruit juice beverages is recommended:

Fruit juice type	**Recommended Addition**
Orange juice	500 - 700 mg/l
Lemon juice	400 - 600 mg/l
Grapefruit juice	500 - 1000 mg/l
Grape juice	250 - 400 mg/l
Tropical mixture	250 - 500 mg/l

The prepararion of low-calorie fruit juice based drinks includs following steps:

a) Preparation of a concentrated Stevia mixture. By heating the water to 30-50°C a faster solution is reachable

b) Preparation of a concentrated citric acid solution of 50%. Heat water also to 30°C.

c) Resolving of fruit juice concentrate and adding aromas.

Mix a), b) and c) by a proportional dosing pump.

6.2.1 Low-calorie orange nectar with 50% juice

Preparation of 100 litre of a low-calorie orange nectar needs

Ingredient	**Quantity**
Orange juice concentrate with 60° Brix	9,52 kg
Processed water	90,48 l
Citric acid	0,58 kg
Stevia	0,05 kg

6.2.2 Low-calorie orange juice beverage with 30% juice

Preparation of 100 litre of a low-calorie orange juice beverage with 30% juice needs

Ingredient	Quantity
Orange juice concentrate with 60° Brix	5,70 kg
Processed water	94,30 litre
Citric acid	0,40 kg
Stevia	0,06 kg

6.2.3 Low-calorie orange beverage with 8% juice

Preparation of 100 litre of a low-calorie orange beverage with 8% juice needs

Ingredient	Quantity
Orange juice concentrate with 60° Brix	1,520 kg
Processed water	98,480 litre
Citric acid	0,300 kg
Stevia	0,065 kg

6.2.4 Low-calorie orange beverage with 4% juice

Preparation of 100 litre of a low-calorie orange beverage with 4% juice needs

Ingredient	Quantity
Orange juice concentrate with 60°Brix	0,76 kg
Processed water	99,24 litre
Citric acid	0,22 kg
Stevia	0,07 kg

7. Basic formulas for sugar free chocolate

Conventional chocolate contains about 40% sucrose or sucrose-lactose mixture. That means changing sucrose with an intense sweetener do not result automatically in a chocolate, because of other functional properties of sucrose. For the preparation of "diabetic chocolate" sucrose was substituted normally by 30% sorbitol and 10% other chocolate ingredients (mostly cocoa butter). Although this reduced the absorbable carbohydrate it simultaneosly increased the fat content, which was undesirable for other dietary reasons. Through the use of fructose or polydextrose more attractive diabetic chocolates can be introduced. Similarly for filled chocolates a sorbitol-based fondant type relied on a fat-rich praline-type centre.
Isomalt, malbit and lactitol can be used in the production of a low-calorie chocolate. They have a triple advantage of being low in readily absorbable carbohydrate (like fructose), low in energy content (like polydextrose), and sweet in taste (unlike polydextrose). To give a diabetic or a low-calorie chocolate a good sweetness, Stevia can be used in small amounts.

The normal process of production of a chocolate is described below. For every bulk sugar substitute an adaption of the temperature is required.

Process description:

1. Mixing/kneading	Bulk sugar substitute, cacao ingredients, milk ingredients are mixed batchwise in a Z-kneader to a homogeneous chocolate groung paste. Mixing time: 10 min Mixing temperature: according need of bulk sugar substitute Fat content: cacao ingredients added up to a fat content of ca. 30% for milk chocolate and ca. 25% for bitter chocolate
2. Refining	The chocolate paste is refined on a traditional five-roll refiner to a chocolate ground powder. Particle size is measured by micrometer: Milk chocolate 22µm, 24µm, 26µm, 28µm , 21µm Bitter chocolate 28µm, 27µm, 28µm, 28µm, 22µm

3. Conching	Total conching time 22 h Dry conching time 20 h Liquid conching time 2 h Addition of the rest of cacao butter to reach the total fat content: After 20 h Addition of lecithin, vanillin and stevia: After 21 h Conching temperature: according need of bulk sugar substitute Conche type: Petzholdt rotary conche type PVS 100

7.1 Chocolate on the basis of fructose

The use of fructose in chocolate manufacture requires special treatment beside the known technique:

a) Fructose crystals pulverise less easily under shock or shear than crystals of sucrose. It is necessary to use more energy to obtain a particle-size range equal to that of icing sugar.

b) Fructose crystals, and especially ground crystals, have tendency to agglomerate accentuated by their hygroscopicity.

c) It is necessary to avoid the presence of moisture in the ingredients and in the manufacturing plant and atmosphere.

d) The particle size of fructose influences the spezific surface area which in turn influences hygroscopicity. A particle size of approximately 200 μm is recommended.

e) Temperature, especially during conching, is important in determining wether fructose will agglomerate. A conching temperature of approximately 40°C is recommended.

f) Manufacturing should be carried out as quickly as possible to reduce the change of moisture pick-up.

Recipe for 100 g bar of Milk chocolate

Ingredient	Quantity
Milk powder	21,50 g
Fructose	30,00 g
Starch	1,00 g
Hazelnut pulp	11,24 g
Cacoa butter	36,00 g
Lecithin	0,20 g
Aromas	al gusto
Stevia	0,06 g

Recipe for a 100 g bar of Milk chocolate with nuts/raisin

Ingredients	Quantity
Milk powder	22,00 g
Fructose	27,00 g
Starch	1,50 g
Cacao butter	30,00 g
Lecithin	0,20 g
Stevia	0,05 g
Aromas	al gusto
Hazelnuts, half	9,60 g
Raisins, intact	9,65 g

For the preparation of a diabetic chocolate it is recommended to eliminate the raisons, because of glucose and increase cacao butter to 35 g and the hazelnuts to 14,25 g to get a pure hazelnut chocolate.

7.2. Chocolate on the basis of lactitol

The preparation of lactitol-containing chocolate is similar to that of its sugar-containing counterpart, since lactitol fine powder is only slightly hygroscopic and has little impact on the viscosity of the chocolate mass during conching. Other important properties of a lactitol-containing chocolate are:

a) it is easy to wrap of the low hygroscopicity of lactitol

b) it has a good taste, but an additional intense sweetener such as Stevia is needed

c) it has a reduced calorie content because of the caloric value of lactitol and a lower fat content than sorbitol-containing chocolate.

Recipe for 100 g bar of Milk chocolate

Ingredient	**Quantity**
Cacao	20,00 g
Cacao butter	20,00 g
Lecithin	0,30 g
Lactitol	51,30 g
Sodium caseinate	4,40 g
Butter oil	3,90 g
Stevia	0,10 g

Recipe for 100 g bar of Bitter chocolate

Ingredient	**Quantity**
Cacao	45,00 g
Cacao butter	10,00 g
Lecithin	0,50 g
Lactitol	44,35 g
Stevia	0,15 g

7.3. Chocolate on the basis of Malbit

Bitter and milk chocolate can be produced with Malbit crystalline by applying normal manufacturing process.
To obtain a Malbit chocolate with good properties the following precautions must be taken:

a) A temperature of 46 °C must not be excedded during kneading, refining and conching processes, as well as in storage tanks and during preheating phase when tempering the malbit chocolate. Higher temperatures increase very rapidly the viscosity giving the chocolate an unmanageable, sandy texture.
Control of local temperature so that it does not increase in the conching is especially important.

b) The sandy effect is aggravated by the presence of moisture, either in the Malbit crystalline, or in other ingredients such as milk powder, or by absorption during kneading, refining and conching.

c) The tempering temperature should be 31°C for a bitter chocolate and 28°C for a milk chocolate.

Recipe for 100 g bar of Milk chocolate

Ingredients	**Quantity**
Cacao liquor	9,00 g
Cacao butter	27,84 g
Whole milk powder	14,50 g
Skimmed milk powder	4,00 g
Malbit	44,06 g
Lecithin	0,48 g
Vanillin	0,02 g
Stevia	0,10 g

Recipe for 100 g of Bitter chocolate

Ingredients	**Quantity**
Cacao liquor	42,00 g
Cacao butter	13,50 g
Malbit crystalline	44,00 g
Lecithin	0,28 g
Vanillin	0,02 g
Stevia	0,20 g

8. Basic formulas for low-calorie diet cakes

Formulation and poduction of low-calorie baked goods require creative use of non-standard food ingredients that are not typically found in traditional bakery products. These ingredient replacement can effect the multiple ingredient interactions in baked goods which influence texture, stability, flavor and sweetness. The use of these reduced-calorie non-standard food ingredients greatly effects the chemical and physical characteristics of baked goods including flavor, grain and texture, richness, aeration, tenderness and stability. Caloric reduction in baked goods often requires a reformulation using various reduced-calorie ingredients to build in the desired properties of the finished baked goods. In addition, ingredient trials and experimental duplication are often required to understand these complex ingredient interactions.

Sugar provides many functional attributes to baked goods in addition to sweetness. The character of baked goods is gratly dependent on the chemical behavoir of sugar. In cookies, high sugar levels combined with low moisture provide the crisp and brittle texture desired in sugar snap cookies. In high moisture systems such as cakes, sugar retards the gelatinization of starch which has a tenderizing effect on cake texture. Sugar also provides humectancy for baked goods which provides moistness, tenderness and a perservative effect.

Intense sweeteners as Stevia can be used to replace the sweetness contribution of sugar in reduced-calorie baked goods. In order for them to be effective in bakery systems they must be heat stable like Stevia.

Reduction of sugar's bulk in baked goods leads to formula imbalance, producing undesirable results. The partial or complete removal of sucrose from cookies dough tends to produce a cookie with a flaky texture typical for biscuits. In addition, the replacement of sucrose with humectant ingredients tends to produce a soft/chewy texture to the products. The overall changes in sugar-reduced cookies tend to make them less acceptable to consumers in general. The complete removal of sugar from yellow cake would not provide a one third caloric reduction. In addition, structural failure occures in yellow cake when sugar was completely removed. Reduction of quality is small when only 25% of sugar is replaced, but this small reduction in sugar provided no meaningful reduction in calories.

The majority of insoluble bulking agents used in reduced-calorie baked goods are mainly dietary fibers derived from grain sources, legumes, fruits and stalks (i.e. celluloses). There are currently over 100 commercially available dietary fiber ingredients. Incorporation of insoluble bulking agents in baked goods often requires special handling or changes in normal production process.

Dietary fibers tend to absorb large quantaties of water which dilute calories, but also result in mixing and dough handling problems. The behavior of reduced-calorie products can be affected by the rate of hydration of the fibers. Presoaking fibers prior to use is often necessary to provide the needed functionality.

Insoluble bulking agents have been the key factor in the development of really calorie-reduced baked goods.

8.1 Recipe for industrial production of Yellow Cake

The production process has follwing steps:

a) Blend fructose, polydextrose, starch, baking powder, emulsified shortening, flavors and Stevia

b) Blend cake flour, salt, emulsifier, non-fat dry milk and frozen egg white

c) Blend frozen whole eggs, 44% of water, perservative and color

d) Rest of water

e) add slowly b) to a) and mix, add part c) and scrape down, mix until smooth and add rest of water until smooth

f) after the preparation above, scale 400 g into a 20 cm cake pan (greased or paper lined), bake at 190°C for 30 min.

Ingredients	**Quantity (%)**
Cake flour	25,84
Water	27,01
Polydextrose	13,75
Egg white (frozen)	12,37
Emulsified shortening	5,50
Whole egg (frozen)	4,12
Fructose (cyrstalline)	2,75
Starch	1,65
Emulsifier	1,65
Non-fat dry milk	1,38
Baking powder(slow)	1,38
Baking powder(double)	1,38
Salt	0,55
Flavors	0,36
Stevia	0,20
Preservative	0,10
Color	0,01

8.2 Recipe for Yellow Cake Dry Mix for home preparation

The production process has following steps:

a) Blend sorbitol and Stevia to form a preblend

b) Blend part A together with the preblend under a)

c) Add slowly part B and mix to a uniform blend

d) Pack the dry mixture

Part	Ingredients	Dry mix quantity (%)
A	Sorbitol, crystalline	16,51
	Maltodextrin	16,70
	Polydextrose	12,50
	N-Flate (National Starch and Chemical Corp.)	7,30
	Sodium bicarbonate	1,25
	Butter concentrate	0,30
	Vanilla flavor	0,14
	Stevia	0,20
B	Cake flour	38,50
	Cellulose	3,50
	Glucono-delta-lactone	2,30
	Salt	0,60
	Xanthan gum	0,20

8.3. Recipe for industrial production of a Chocolate Cake

The production process has follwing steps:

a) Blend fructose, polydextrose, wheat starch, 22% of baking powder, shortening, N-flate and Stevia

b) Blend cake flour, salt, non-fat dry milk, cocao, CMC and 78% of baking powder

c) Blend fresh whole eggs and 60 % of water

d) Rest of water

e) add slowly b) to a) and mix, add part c) and scrape down, mix until smooth and add rest of water until smooth

f) after the preparation above, scale 400 g into a 20 cm cake pan (greased or paper lined), bake at 190°C for 30 min.

Ingredients	**Quantity (%)**
Water	43,01
Cake flour	19,03
Whole egg (fresh)	9,51
Shortening	7,23
Fructose	4,76
Polydextrose	4,76
Cocao	4,28
Wheat starch	2,85
Non-fat dry milk	0,95
Baking powder	2,66
N-Flate	0,38
Salt	0,38
Stevia	0,20
CMC	0,14

8.4 Recipe for the industrial production of Oatmeal Cookies

Ingredients	Quantity (%)
Flour	25,35
Polydextrose	20,28
Oats	13,44
Water	16,17
Raisins	7,61
Shortening	4,44
Corn syrup	3,11
Molasses	3,11
Non-fat dry milk	2,03
Fructose(crystalline)	1,45
Soda	0,98
Spice/flavor	0,74
Salt	0,63
Baking powder	0,41
Glycerin	0,05
Stevia	0,20

9. Basic formulas for confectionary

As it was stated for chocolate and for low-calorie cakes it is also necessary in candies or other type of confectionary to replace sugar. With the replacment of sugar it is difficult to reproduce exactly existing confectionary products. Processing is more complicated and may require different manufacturing plant and increased boiling temperatures requiring more energy. The increased hygroscopicity of certain alternative bulk sweeteners requires improved packing.

The typical transparent glass of the boiled sweet is a special property of the sugar-glucose mixtures used to make drop-formed or deposited sweets. Only sorbitol so far has been used significantly as an alternative for this purpose. Lycasin is also physically suitable for this purpose.

In the following recipes of confectionary with isomalt, fructose, malbit and polydextrose are presented.

9.1 Recipe for moulded candies using isomalt

Production process includs following steps:

a) Boil isomalt and water in a suitable cooker at 142°C.

b) Apply vaccum (730 Torr) for 3 min. Boil without vaccum at 160 - 165°C.

c) Cool to 110 - 115°C on a cooling table.

d) Add acid, color solution, flavor and Stevia and mix.

e) Pour into Teflon-lined moulds.

Ingredients	**Quantity (%)**
Isomalt	74,10
Water	24,80
Citric acid	0,70
Flavor	0,10
Color solution	0,05
Stevia	0,25

9.2 Recipe for hard candies using fructose

The conventional process for manufacturing sucrose-based hard candies involves dissolving sucrose and other carbohydrate syrups and then boiling to remove the water. This cannot be applied to fructose-based hard candies as fructose does not readily form a glass and, due to its hygroscopicity, tends to become sticky.

The following process overcome this problem by the addition of powdered fructose to a fructose melt. The mass produced is formed into hard candies by conventional methods.

9.2.1. Candies formed by drop-rolling

Production process:

a) Heat fructose to 110°C.

b) Add unter stirring citric acid and cool to 105°C.

c) Add and stirring powdered fructose, flavor, color and Stevia

d) Cool to 48°C and form into candies by drop-rolling.

Ingredients	**Quantity (%)**
Fructose	49,1
Powdered fructose	49,1
Citric acid	1,5
Lemon flavor	0,1
Stevia	0,2
Color	al gusto

9.2.2 Candies formed by moulding

Production process:

a) Heat fructose to 120°C.

b) Add with stirring peppermint flavor, powdered fructose and Stevia.

c) Transfer to a pre-heated hopper (105°C) and deposit into moulds.

Ingredients	**Quantity (%)**
Fructose	69,8
Powdered fructose	29,9
Peppermint flavor	0,1
Stevia	0,2

9.3 Recipes for soft caramels, toffees and chewy fruits using Malbit

Soft caramels, toffees and chewy fruits can be produced by using the usual manufacturing process. The following changes from the normal sugar procedure are necessary:

a) To obtain a final product with 7-9% residual moisture the cooking temperature of the boiled Malbit mass must be increased to 135-140°C. A sucrose chewy fruit is normally cooked at 120-124°C.

b) The forming temperature should be lower. At temperatures of 30-35°C the mass does not stick to the size rollers and the cutting knife. The amount of hardend fat must be higher than for sucrose chewy fruits.

Process description:

1. Cooking	Disolve Malbit cyrstalline in the water. Add the premelted fat and the lecithin. Mix this premix for 5 min. at high speed. Cook the mass at 135°C for the same time as the sugar sweetened type. Turn off the steam, add the chewy mass and mix at high speed for a short period.
2. Forming	Pour the mass on to an oiled cooling table and add acid, flavor, color and Stevia. Temper at 45°C and pull the mass during a period of 10 min. Temper the pulled mass at 30°C. Process the mass on a cut and wrapping machine.

Following ingredients are used for the recipe:

Ingredients	**Quantity (%)**
Malbit crystalline	76,5
Hardend fat *	10,7
Lecithin	0,3
Chewy mass *	10,7
Citric acid	1,2
Cherry flavor	0,2
Color solution(10%)	0,1
Stevia	0,3

* = special recipe for chewy mass and recommendation for hardend fat are available

9.4 Recipe for a hard candy using polydextrose

With polydextrose good candies with about half of the calories and not promoting tooth decay can be produced. These can be made on existing equipment with minimal changes in the manufacturing process. Ploydextrose can be used to replace part of the sucrose, corn syrup and some fats. It melts above 130°C and after cooling produces a clear glassy product with a brittle texture. Boiling temperatures of polydextrose solutions tend to be sligtly higher than equivalent sucrose solutions. Polydextrose prevents the cold flow and storage problems of hydrogenated glucose syrup and also provides a true calorie reduction.

Ingredients	**Quantity (%)**
Polydextrose	38,82
Isomalt	38,52
Water	20,51
Sodium citrate	0,10
Citric acid	1,50
Flavor	0,15
Color	0,10
Stevia	0,30

10. Basic formulations of sugar free edible desserts

Under this term dairy and non-dairy products are summarized as ice cream, soft ice, water ice (sorbet), ice lollies and sherbets.

10.1. Low calorie ice cream

The term denotes the presence of dairy products, such as milk, cream, skim milk, evaporated milk, condensed milk or butter. Minimal levels of milk are defined as milk fat. Usually 10% are required for the product to be called ice cream. Some countries' food regulations also define "Milk Solids Non FAT (MSNF)" mainly consisting of lactose and proteins. In the USA a minimum of 10% MSNF is required.

Production process:

Simmed milk, fructose, stabilisiers/emulsifiers are added to cold water. The liquid is heated to 74°C and pasteurized for 15 min. Homogenising follows at 230 kg/cm², whereafter the mass is flash cooled to +4°C. At this stage flavor and Stevia is added and stirred in. The mix is maintained at this temperature 24 hours for conditioning. After conditioning pump the mix to a continuous freezer. Overrub is adjusted to 90-100%. The ice cream is stored at -40°C prior to shipment.

Recipe:

Ingredients	**Quantity (%)**
Skimmed milk	33,0
Water	49,9
Fructose	15,0
Flavor	0,5
Stabilisers/Emulsifiers	1,5
Stevia	0,1

10.2. Water ice (Sorbet)

Products not containing milk solids are termed ices or water ices. They are in essence sweetend and flavored water, frozen in form of small cyrstals with air entrapped between.

Production process:

Fructose, sorbitol, color and stabilisier/emulsifier are added to cold water under stirring. The liquid is heated to 75°C and pasteurised for 15 minutes. Homogenising follows at 30 kg/cm², whereafter the mass is flash cooled to +6°C. At this stage citric acid solution, flavor and Stevia are stirred in. The mix is maintained at this temperature for 30 minutes and then pumped through the continuous freezer. Overrun is adjusted to 50%. The water ice is stored at -40°C prior shipment.

Recipe:

Ingredients	**Quantity (%)**
Fructose, crystalline	11,000
Sorbitol, crystalline	11,000
Anhydrous citric acid (50% solution)	0,900
Stabilizer	0,500
Lemon flavor	0,039
Color, Riboflavin	0,001
Stevia	0,080
Water	76,480

10.3. Sherbet

Sherbets are low milk-solids frozen desserts. US Food and Drug Regulations determine that their total milk solids shall between 2 and 5%. Sherbet is to be sweetend "with nutrive carbohydrate sweeteners" and it should weigh not less than 0,72 kg per litre which corresponds to max. 30% overrun.

Ingredients	**Quantity (%)**
Whole milk	32,000
Maltodextrin	5,000
Polydextrose	5,000
Fructose	3,000
Fruit puree	15,000
Water	38,519
Stabilisier/Emulsifier	0,400
Citric acid	1,000
Stevia	0,080
Color	0,001

11. Energy reduced jams

Usual jam has a sugar content between 50-70%. Energy reduced jam can be produced with alternative bulk sweeteners as fructose, malbit, sorbitol or with incorporation of polydextrose. The use of non-nutrive sweeteners such as Stevia are also possible by increasing the fruit pulp.

Viscosity is one of the important physical properties that affect the quality of jam. When intense sweeteners like Stevia, without addition of sugar, are used, low methyl pectin(LM-pectin) is sucessfully used to improve the texture of the jam. Color of jam is also, like viscosity, one of the major quality criteria.

11.1 Basic recipes for jam using malbit

Malbit jam can be produced like sugar jams without difficulty. The shelf-life of the final product is excellent due to the good restistance of malbit to microorganisms and moulds.

Ingredients	**Apricot jam (%)**	**Strawberry jam (%)**
Malbit crystalline	33,50	38,50
Apricot pulp	41,00	------
Strawberry pulp	------	34,30
Water	24,90	26,70
Pectin HM slow set	0,25	------
Pectin HM rapid set	------	0,20
Tartaric acid	0,25	------
Citric acid	------	0,20
Stevia	0,10	0,10

11.2 Low calorie jam

This type of jam has not more than 7% of calories present in jam from sucrose. This diabetic jam can be stored for about 6 months without any changes in quality.

Ingredient	Quantity (%)
Fruit pulp	98,4
LM-Pectin	1,5
Stevia	0,1

12 Basic formula for sugar free chewing gum

Sugarless chewing gum and bubble gums can be easily produced using a combination of a alternative bulk sweetener and Stevia. To produce a good quality the required gum base varies between 25 and 30% depending upon the required chewiness and type of gum base. The following formulation uses malbit as bulk sweetener together with Stevia.

Production process:

a) Preheat a Z-kneader to 60°C.

b) Add the gum base and knead for 1 min.

c) Add the malbit liquid and knead for 4 min. During this the gum base must be completely melted ensuring that the temperature does not increase above 60°C.

d) Add one third of the malbit cyrstalline and mix for 8 min.

e) Add the second one-third of the amounts if malbit crystalline and mix again for 8 min.
f) Add the last part malbit crystalline as well as the flavor, glycerol and Stevia. Continue the kneading process for a further 8 min.

g) On completion of kneading, discharge the chewing gum and temper the mass at 35-40°C.

h) Transfer the tempered chewing gum mass to the hopper of the chewing gum extruder and extrude through staggered reducing rollers.

i) After passing through transverse and longitudinal cutting rolls wrap the chewing gum sticks.

To prevent problems during the manufacturing process the following rules must be observed:
1) The total kneading time should be less than 30 min.
2) The temperature of the chewing gum mass must be kept below 60°C during the kneading process.

Higher temperatures and longer kneading times reduce the quality ofb the finished products. The mass shows a higher tendency to stickiness, and the chewing gum loses elasticity and chewiness.