1. INTRODUCTION

Diabetes is a Latin word that indicates one of the most common diseases among the human being. The diabetes is commonly spread all over the world among all races and age groups, from chronic diseases. The percentage of the infection is about 10% in the different parts of the world. The term diabetes mellitus describes a metabolic disorder of multiple a etiology characterized by chronic hyperglycemia. Diabetes mellitus is a disease in which the body becomes unable or less efficient to convert glucose in the blood into energy and as a result, the amount of glucose (sugar) in the blood starts to increase **(Ridgwetl, 1996; WHO, 2006; Weinger, 2009; Eltoum, 2017) .**

Jam is generally defined as a solid gel made from fruit pulp or juice, sugar and added pectin. The jam can be made from a single fruit or acombination of fruits. The fruit content should be at least 40% with a total sugars content of not less than 68% .

Diabetic jam is low calorie it is a processed product prepared with fruits, vegetables or flower petals processed with sugar substitute allowed for health.

Main objective

The main goal of this study is to evaluate the chemical, physic-chemical and microbial characteristics of imported diabetic jams in Khartoum local markets.

Specific objectives

i. To determine the glucose, fructose and sucrose in jams .

ii. To determine the pH, T.S.S. and titrable acidity in the jams.

iii. To determine the total viable bacterial count, mould and yeast and coliform count in the jam

2. LITERATURE REVIEW

2.1 Diabetes mellitus

Diabetes is a Latin word that indicates one of the most common diseases among the human being because the percentage of the infection is about 10% in the different parts of the world. The disease was discovered for many years ago but the treatment was not defined till the coming of a Dutch doctor (Linger Hans) who discovered the role of some parts of the pancreas and its relation to reduce the level of sugar in the blood. In 1921, two Canadian doctors were discovered the insulin which was found to regulate blood sugar and to overcome this dangerous disease (**Weinger, 2009**).

The term diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both**.** Diabetes mellitus may present with characteristic symptoms such as polyuria, polydipsia, polyphagia, weight loss, blurred vision, recurrent vaginal, urinary tract infections and fatigue **(WHO, 2006; Weinger, 2009; Eltoum, 2017).**

The most common complication with diabetes are macrovascular such as coronary heart disease, peripheral ascular disease, cerebrovascular disease and microvascular such as retinopathy, nephropathy, and neuropathy **(Weinger, 2009)**.

2.1.1 Classification

In 1998 a new classification system based upon the aetiological factors was proposed by the WHO. This system has now become the accepted system for classifying diabetes mellitus (DM).

2.1.1.1 Type 1 DM: Diabetes type 1 (insulin dependent diabetes mellitus) is characterized by (β) cell destruction and leads to absolute insulin deficiency, either immune-mediated or idiopathic. It can occur at any age and it is usually acute, and

affects younger people (children, adolescents, and young adults). All patients with type 1 diabetes eventually become insulin dependent.

2.1.1.2 Type 2 DM: Increased prevalence of obesity, increased incidence of insulin resistance (mainly due to obesity) and a progressive decline in (β) cell secretory function are the major factors that lead to hyperglycemia in patients who develop type 2 diabetes. This is a progressive disease, characterized by a progressive decline in insulin secretion, resulting in increasing medication requirements and ultimately insulin treatment for many patients with this disorder. The distinction between type 1 and type 2 diabetes is usually made clinically . The two types of diabetes can occur at any age, while type 1 diabetes usually effects younger people (children, adolescents, and young adults) and type 2 diabetes occurs in those over the age of 40 years. Individuals who develop type 2 diabetes are more likely to have a family history of the disease and are commonly obese or overweight.

2.1.1.3 Other types of diabetes: Other types of diabetes may be caused by a variety of factors including but not limited to genetic defects in (β) cell function, genetic defects in insulin action, diseases of the exocrine pancreas such as cystic fibrosis **(WHO, 2006; Weinger, 2009).**

2.1.2 Diagnosis

Diabetic diagnosis depends on disease history and accurate clinical diagnosis. If the rate of blood sugar greater than 120 mg during different two intervals and with fasting or if the rate of blood sugar was randomly greater than 200 mg with the prevalence of previous symptoms **(Eltoum, 2017).**

Table (1): Diabetes mellitus rate per 1000 population in Sudan (2015)

State	Rate per 1000 pop
The Northen	41
Red Sea	24
Nile Rever	36
Kassala	4
Gedarf	62
Sennar	25
Blue Nile	13
Al- Gesira	19
Khartoum	67
White Nile	11
North Kordofan	22
South Kordofan	12
West Kordofan	2
East Darfur	0
South Darfur	4
Centeral Darfur	10
West Darfur	9
North Darfur	2

Source: Federal Ministry of Health, (2015).

2.1.3 Treatment

According to **Eltoum (2017)**, there are three main treatments for treating diabetic patients:

2.1.3.1 Diet: Healthy diet was preferred to everybody if he is diabetic or not. Till now, medicine did not find any alternative for diet regime to control hyperglycemia although insulin and other drugs were discovered. Therefore, diet regime is the main treatment and plays the main role in decreasing the health symptoms for hyperglycemia and deleting its complications on patients through the following instructions**:**

- Consulting the doctor to determine the important calories for the patient body which depend mainly on the optimum body weight.
- Eat his food according to time and quantities that were determined by the diet regime.
- Avoiding eating diet with high sugar content and concentrate on eating foods that contain fibre.
- Avoid food with high salt such as (pickles and salted nuts).
- Use vegetable oils instead of animal fats and butter.
- Avoid food rich in cholesterol (Liver, egg) because diabetes are subject to heart diseases.
- Eat fish twice a week instead of other meat.
- Foods that diabetes was permitted to eat were leafy vegetables (lettuce, cucumber, carrot) which contain fewer calories.
- Some foods must be eaten in less quantities such as (rice, bread, meat, fish, chicken and starchy vegetables e.g. potatoes).
- Foods must be avoided to eat such as sugar, sweets, chocolates, biscuit, honey and soda.
- Diabetes who depends on insulin should take his meal after half an hour after injecting insulin.
- Daily practice any types of sports.

2.1.3.2 Gym program (physical practices): Regular Gym exercises help in decreasing hyperglycemia, decreasing excess weight, accelerating accelerate blood circulation and strengthening heart muscle. Also, it helps in declining the level of fats in blood. It is better to practice Gym program 3-4 times a week for half an hour and when doing unusual Gym program diabetic patient must eat an addition quantity of food or minimize the insulin dose to avoid decreasing sugar level in blood.

2.1.3.3 Drug regime: If diabetes cannot control hyperglycemia by diet regime or Gym program in type two of diabetes (adults patients), therapy control must be done in form of tablets or through insulin injections. Hyperglycemia drugs help in decreasing blood sugar by enhancing β cells in pancreas to secrete insulin and minimize increasing secretion of sugar from lever or by make body cell more sensitive to insulin which keeping the balance of blood sugar.

2.1.3.3 Examples of hyperglycemia drugs

According to **Eltoum (2017)** the following drans are usually used for lowering blood sugar:

A) Decreasing drugs:

- Sulfonylurea compounds such as Daonil, Gliclazide, Glimerpiride, Dimicrone and Amaryl).
- Piogoanide compounds such as Glucophage.
- Glucobay drug.
- Rebaglanide group such as Novonorm.
- Thiazolidinediones groups which increasing the response of cells to insulin such as Avandia, Rosiggliazone, Pioglitazone and Pionnorm.

B) Insulin: It is a hormone secreted by special cell in pancreas called β cells. Insulin has a role as catalyst in glucose entrance in body cells in order to do their metabolic and hence keep the natural level of blood sugar. In ancient times Insulin

was being extracted from cows but, recently experts produced insulin hormone from *E. coli* bacteria and there was another type extracted from bread yeast which it is widely used. In general, there are different types of insulin depending on its effect:

i. Rapid effect insulin (pure): such as Lyspero and Hyomalog. Its effect start during 5- 15 minutes, its effect continues to an hour and end after 2-3 hours.
ii. Rapid effect short range insulin (water): Its effect start after 20 minutes and its strength will be after 2 hours and end after 4-6 hours.
iii. Medium effect insulin: It is called (Elakar) (NPH): Its effect starts after 2 hours and continues to 12 hours.
iv. Long effect insulin (Ultra lente): Its effect starts slowly but continues to long period may reach 18- 24 hours.

Table (2) Shows the different types of insulin and its effect periods.

Table (2): Insulin types and their effects

Type of insulin	**Beginning of the effect**	**Peak of the effect**	**Period of the effect**
Rapid effect insulin (pure)	20 minutes	2 hours	4-6 hours
Medium effect (Alakar)	2 hours	5 hours	12 hours
Long effect (Ultra lente)	4 hours	9-12 hours	18- 24 hours
Mixed	20 minutes	12 hours	24 hours

Eltoum, (2017)

2.2 Jam processing

2.2.1 Jam definition

Jam is generally defined as a solid gel made from fruit pulp or juice, sugar and added pectin. The jam can be made from a single fruit or acombination of fruits. The fruit content should be at least 40% with a total sugars content of not less than 68% **(ICUC,2004).**

2.2.2 Jam ingredients

For making a good jam three main ingredients are needed this are pectin, sugar, and citric ascid. The pectin forms the gel structure which makes the jam firm rather than a runny pulp of juice. The sugar and acid are necesssary to make pectin set into a firm gel **(Malcolum, 2005; Pradeep, 2013).**

2.2.2.1 Pectin: Pectin is found in most fruits with different levels according to fruits type maturity . Unripe fruits have a lots of pectin which gives the fruit its firm and hard texture . As a fruits ripens , the pectin is broken down and so the fruit become soft and easy to eat . Some fruits provide enough pectin for jam or jelly making whilst others need to have pectin added from another source. Usually, fruit with high pectin content can be added to fruit with a low pectin content to give an adequate amount of pectin **(Kordylas, 1990; Pradeep, 2013).**

The different types of commercial pectin's, which are according to their application are:

2.2.2.1.1 Rapid set pectin: Traditionally used for jams and marmalades.

2.2.2.1.2 Slow set pectin: Used for jellies and for some jams and preserves, especially using vacuum cooking at lower temperatures. Also important for higher sugar products like bakery and biscuit jams, sugar confectionery, etc.

2.2.2.1.3 Stabilizing pectin's: Used for stabilizing acidic protein products such as yoghurts, whey and soya drinks against heat processing.

2.2.2.1.4 Low methyl ester and amidated pectin's: Used in a wide range of lower sugar products, reduced sugar preserves, fruit preparations for yoghurts, dessert gels and toppings, and savory applications such as sauces and marinades. Can also be used in low acid high sugar products such as preserves containing low acid fruits (figs, bananas) and confectionery.

2.2.2.2 Sugar: Sugar is present in all fruits but it is not enough to presrve jam or jelly .in ordre to preserve the jam or jelly a higher sugar concentration is needed,

also, it helps the pectin to form a firm gel structure. Normally, an equal amount of sugar is added to the fruit pulp or juice and then the excess water is evaporated to give the required sugar concentration **(Kordylas,1990; Pradeep, 2013).**

2.2.2.2.1 Artificial sugar: Low colorie sweeteners are sugar substitutes that have zero calories and do not raise blood glucose levels through eating them, which makes them a preferable choice for diabetic food patients such as jams, drinks, candies, cookies and medicines **(Robert, 2011).**

Low-cal sweeteners are neither carbohydrate, nor fat and can be added to diabetic meal plan such as:

Aspartame: sphenylalanine and its called it is Canderel or Equal or Nutra sweet or Sanecta. The sweetness of aspartame is more than the sweetness of sucrose by about 200 times. The advantage of synthetic of aspartame as it is dipeptide compound, it is easily absorbed and digested through the various tracks of the trajectories of sugars, making it suited to sweeten the food of diabetic patients. Also, it at is a low calorie ingredient and it can be used in foods for people whishing to reduce their weight **(Aman, *et.al*, 1999).**

Malitol: A sugar alcohol or polyols, made from maltose has 75-90% of the sweetness of sucrose (table sugar) and nearly identical properties, except for browning. Used to replace table sugar because it has fewer calories, does not promote tooth decay, and has a somewhat lesser effect on blood glucose, large quantities can have a laxative effect **(Robert, 2011).**

Mannitol: Another of the naturally accuring sugar alcohol or polyols, can act as diuretic agent and weak renal vasodilator. It was originally isolated from the secretions of the flowering ash, and can be synthesized through the hydrogenation of fructose or extracted from a wide variety of plants**. (Robert, 2011).**

Saccharin: Sodium Saccharin (benzoic sulfimide) is an artificial sweetener with effectively no food energy that is about 300–400 times as sweet as sucrose but has

a bitter or metallic aftertaste, especially at high concentrations. It is used to sweeten products such as drinks, candies, cookies, and medicines.

Sorbitol: Is a sugar alcohols or polyols metabolized slowly by the body. Obtained by reduction of glucose. Sorbitol is found in apples, pears, peaches, and prunes. It is also sold as glucitol, Sorbogem and Sorbo Stevia **(Robert, 2011).**

2.2.2.3 Acid: Acid is necessary for three purposes: (1) it helps the pectin to set into a firm gel. (2) it prevents sugar crystallization. (3) it improves jam colour and flavour. All fruits contain organic acid which differ in the diffferent fruit varieties. Some fruits provide enough acid for a good jam, while in others acid should be added from another source. The organic acid are usually citric acid, malic acid and tartaric acids. These acids are available in powdered form if the powdered acids are not available, fruits with high acid content can be mixed wirh fruits with low acid content to give enough acid for a good gel formation, Lemon or lime juice is generally used. Also, some unripe fruit can provide a high acid content **(Kordylas, 1990 and Pradeep, 2013).**

2.2.3 Jam types and recipes

Different jam types were produced by **Girdhari-lal, *et. al*. (1986) and Hui (2006)** at large scale production levels. The produced jams and their recipes are given in Table (3).

Table (3): Different jam types and their recipes

Jam type	**Jam recipe**			
	Fruits (kg)	Sugar (kg)	Pectin (g/kg)	Acid (g/kg)
Pineapple	75	75	565	035
orange	50	50	375	250
mango	40	40	500	400
apple	40	44	400	500

Girdhari-lal, *et.al*.(1986); Hui (2006).

2.2.4 Jam processing methods

Jam can be commericially produced by using two methods. The first one is the open pan method which gives the product a traditional flavour with some carmeliztion of sugars . In the second commercial process, jam is produced under vacuum to reduce its boiling temperature to 65-80 ^{o}C. The lower boiling temperature retaining more of the volatile flavouring compounds from the fruit, preventing sugar carmelization and of course redusing the overall energy required to make the product. All the ingredients must be added in careflly measured amounts as too much pectin will make the spread of jam too hard, while, too much sugar will make the jam too sticky **(Anwar, *et.al*. ,2010).**

2.2.4.1 Jam processing steps

2.2.4.1.1 Receiving of raw materials: When the fruit is arrived at the plant, it should be inspected for their quality characteristics, weight and impurities. After that, the fruits are loaded into a funnel -shaped hopper which carry the fruits to in pipes for cleaning and crushing **(Ward, 2000; Elsayaid, 2008).**

2.2.4.1.2 Cleaning, crushing and chopping: As the fruit travels through the pipes, agentle water spray clears away the dirts at the fruit surface. Some fruits, such as citrus and apples may be manually peelled,cored sliced and diced. Cheerries may be soaked and then pitted before being crushed **(Elsayaid, 2008).**

2.2.4.1.3 Cooking: Premeasured amounts of fruit and/or juice, sugar, and pectin are blended in steam cooking kettles and cooked until the mixture reaches the required thickenss and sweetness. Then, the flavouring agents may be added and the mixture is pumped to the filling machines **(Elsayaid, 2008).**

2.2.4.1.4 Filling: Presterilized jars are filled with premeasured amounts of jam. Then, automatically sealed under vacuum condition to insure the sterility of the end product **(Elsayaid, 2008).**

2.2.4.1.5 Labeling and packaging: The sealed jars are mechanically conveyed to a labeling machine. These labels must list truthful and specific information about the product. The jars are then packed into cartons for marketing **(Kopjar and Sajple, 2009).**

2.2.4.1.6 Storage: The jam jars should be stored in a cool, dry, and dark place at temperature between 50 and 70 F. The product should be kept well for at least one year **(Kopjar and Sajple, 2009).**

2.3 Jam quality and specifications

2.3.1 Normal jam

As reported by the **SSMO (2006),** fruits that used in jam production should be clean, uniform with high quality. Only mature fruits, without mould or in the maximum level 10^4 g/ml, excessive bruising or insect damage should be used. Also, stems, leaves, skins should be removed. Moreover, all jam ingredients should be accurately weighed. In addition to that, the pectin powder should be thoroughly mixed with some sugar and boiled water to prevent lumps which lead to a weak gel formation.

Also, according to the **SSMO (2006)** specifications, a good quality jams should have total soluble solids, pH, invert sugar, and titrable acidity, between 65 -70%, 3.1 - 3.4, 20 - 28% and 0.5 - 0.7 , respectively.

Onsa (2007) mentioned that**,** good quality jams should have total soluble solids, pH, acidity and reducing sugars between 67 - 70%, 3.2 - 3.4, 0.3 - 0.8% and 20-28% or 28-32%, respectively.

Elsayaid (2008) reported that a good quality jam should contain 68.0% total soluble solids, 3.6 pH, 0.56 acidity, 62.6% total sugars, 22.9% reducing sugars and 0.5 colour.

As stated by the **Codex (2009),** the quantity of fruit pulp or fruit puree or both used for every 1000 grams of the finished product should be not less than:

(i) 250 grams in the case of redcurrants, blackcurrants, rosehips, browanberries, sea buckthorns or quinces.

(ii) 150 grams in the case of ginger.

(iii) 160 grams in the case of cashew apples .

(iv) 60 grams in the case of passion fruit.

(v) 350 grams in the case of any other fruit.

According to the food processing regulations in the United states, jams should be made with 45 parts fruit or juice to 55 parts sugar. Also, the Federal Food and Drug Administration (FDA) mandates mentioned that all heat- processed canned foods must be free from live microorganisms **(Codex, 2009).**

Javanmard (2010) reported that a good jam should contain total soluble solids, pH and titrable acidity between 67-70%, 3.2-3.4 and 0.3-0.8%, respectively. Numerous quality control checks at all points during the preparation process should be installed for testing taste, colour and consistency.

2.3.2 Diabetic jam

According to the British standard specifications (2005) for jam, the specifications are found to be as follow:

i. The T.S.S not less than 55%.
ii. The normal pH range is 3.1 – 3.2.
iii. Preservatives 200 mg/kg in singly, 1g/kg combination.
iv. Sugars percentage must be less than 30% in jam.
v. Pectin (no – amidated) limited by GMP, amidated about 5g/kg.
vi. The specified jam with (no added sugar) or (lite) may not contain any added monosaccharide or disaccharide or other food added to its sweetening properties.
vii. The titrable acidity is range 0.3 – 0.8 %

Also, according to **GSO (2012)** a good quality of diabetic jam should have total soluble solids not less than 55%, titreable acidity not less than 1% and calorie content not less than 40 calorie.

3. MATERIALS AND METHODS

3.1 Materials

Samples of diabetics jams (Vitrac and Diet) were purchased from Elehssan, Bahri, Khartoum State.

The label information of the diabetic jam sample1 (Vitrac) was as follows: strawberry lite jam (40% less calories), made by vitrac in Egypt. The production date was in 13/12/2016 and the expiry date is in 12/6/2018. The ingredient / consist of the other product following:

strawberry, fructose, pectin, citric acid, T.S.S less than 45% and net weight 290g. Table (4) shows the nutritional information diabetic jam sample 1.

Table (4): Nutritional information of diabetic jam sample 1(Vitrac)

Amount serving per 20g	
Protein	0 g
Total fat	0 g
Total carbohydrate	8 g
Sodium	0 mg
Calories	32kcal

Also, the information found in the label of the diabetic jam sample 2 (Diet) was as follows: strawberry lite jam , made by Diet in spain. The production date was in 10/7/2016 and the expiry date is in 10/7/2018. The ingredient / consist of the other product following: strawberry pulp, fructose (35%), thickeners (pectin and carob-bean gum), lemon juice and antioxidant (ascorbic acid), net weight 375 g, no added

colors and preservatives. Table (5) show the nutritional information diabetic jam sample 2.

Table (5) Nutritional information of diabetic jam sample 2(Diet)

Amount serving per 100g	
proteins	0.5 g
Fat	0 g
Carbohydrates	40.7 g
sugar	40.7 g
fiber	2 g
salt	0.1 g
Energy value	169 kcal

3.2 Methods

3.2.1 Physico-chemical methods

3.2.1.1 Total soluble solids (T.S.S. %)

The total soluble solids as percent in the different samples were measured following the method described by **Onsa (2007)** by using a Hand-Refractometer.

Principle: The index of refraction of substance is a ratio of the light velocity under vacuum to its velocity in the substance which is largely dependent on the composition, concentration and temperature of the sample solution.

Procedure: After the adjustment of the Hand-Refrctometer (No.002603, BS- eclipse, UK) with distilled water, the sample (20C) was placed on the surface

of the refractometer prism, then the prism was closed and the reading was recorded to the nearest (0.00) as T.S.S %.

3.2.1.2 Hydrogen ions concentration

The hydrogen ions concentration (pH) of the different samples was determined as described by **Ranganna (2001).**

Principle: The pH value of the different samples was measured with a pH-meter. After standardization of the pH-meter electrodes with buffer solution, the reading of the sample is recorded as pH value.

Procedure: After standardization of the pH-meter (No.478530, Hanna, India) with buffer solution (pH 4.01 and 7.01), the electrode of the pH-meter was rinsed with distilled water, immersed in the sample and left to stand until a staple reading was achieved. All the reading were expressed as pH to the nearest 0.01-pH units.

3.2.2 Chemical methods

3.2.2.1 Titrable acidity

Titrable acidity of diabetic jam was determined according to **Ranganna (1979).**

Procedure: 50 g + 1 g sample was diluted to 100 ml, and boiled water 30 min then 20 ml of the diluted solution was titrated against (0.1N) sodium hydroxide using phenolphthalein solution (1%) as an indicator. The titrable acidity was calculated as percent citric acid according to the following equation:

Titrable acidity (%) =

$$\frac{[\text{(Titre} \times \text{N (NaOH)} \times \text{equivalent wt of cetric acid} \times 100)]}{\text{Sample volume (ml)} \times \text{initial wt of sample (g)} \times 1000} \times 100\%$$

3.2.2.2 Sugar determination

The sugars determination was conducted in National Center for Research. The High Performance Liquid Cromatography is used for determination of sugars in jam samples.

The device was first set before estimating the sugars in jam samples. The device conditions were as follows:

Mobile phase: Acetonitrile75% and Distilled water 25%

Colum: Insert suction NH_2 5µm 250×4.6 id mm

Detector: RI detector

The flow rate, RI detector temperature, and injector volume were 1.0 ml/min, 27.1ċ - 27.8ċ and 20µl respectively. Appendices (1) , (2) and (3) show the concentration of the standard glucose fructose and sucrose respectively.

3.2.3 Microbial methods

- **Equipments:** Test tubes, Petri dishes, Incubator and Colony counter.
- **Media Used:** Plate count Agar, MacConkey broth, Potato dextrose Agar, EC Broth, Brilliant Green 2% Bile Broth and Peptone water.

3.2.3.1 Preparation of serial dilutions

Aseptically 10 grams of the sample were homogenized in 90 ml of sterile diluent (0.1% peptone water). It was mixed well to give dilution (10^{-1}). By using sterile pipette 1 ml was transferred to a test tube containing 9 ml of sterile diluent and it was mixed well to give dilution (10^{-2}).

In the same was the preparation of serial dilution was continued untill the dilution (10^{-6}). One ml of each dilution was transferred into sterile petri dishes. To each plate 15 ml of sterile melted plate count agar were added. The inoculum was mixed with medium and allowed to solidify. The plate were incubated at 37Ċ for 48 hours. Colony counter was used to count the viable bacterial colonies after incubation and the results were expressed as colony-forming unit (cfu/gram).

3.2.3.2 Total viable count of bacteria

It was carried out by using the pour plate count Method as described by **Harrigan (1998).** Suitable medium for this purpose is plate count Agar.

3.2.3.3 Yeast and mould count

From suitable dilation 0.1 ml was aseptically transferred onto solidified potato dextrose agar containing 1.5 ml of sterile (1 : 10) tartaric acid per 100 ml of medium to inhibit bacterial growth. The inoculum was spreader all over the plate using sterile bent glass rod. Plate were incubated at 28 c for 72 hours. By using colony counter colonies were counted and the results presented as CFU/gram.

3.2.3.4 Determination of coliform bacteria

It was carried out by using the Most Probable Number (MPN) technique.

3.2.3.4.1 Presumptive coliform test

1 ml of each of the three first dilutions (10^{-1}, 10^{-2}, 10^{-3}) was inoculated in triplication of MacConkey Broth tubes containing Durham tubes. The tubes were incubated at 37c for 48 hours. The production of acid with sufficient gas to full the concave of the Durham tube is recorded as positive presumptive test (**Harrigan, 1998).**

3.2.3.4.2 Confirmed test for total coliforms

From every tube showing positive result a tube of Brilliant Green 2% Bile Broth was inoculated by using sterile loop. The tubes were incubated at 37Ċ for 48 hours. Then the tubes showing positive and negative result were record. The Most Probable Number of total coliform was found out by using the Most Probable Number (MPN) tables.

3.2.3.5 Confirming *E.coli* test

From every tube showing positive result in the presumptive test inoculate a tube of EC Broth containing Durham tube. The tubes were incubated at 44.5Ċ for 48 hours. Tubes showing any amount of gas were considered positive. Then the Most Probable Number (MPN) were record. For further confirmation of *E.coli* tubes of EC broth which showing positive result were streaked on (E.M.B) agar Eosin Methylene Blue agar plates. The plates were incubated at 37Ċ for 48 hours.

Colonies of *E.coli* are usually small with metallic green sheen on (E.M.B) agar **(Harrigan, 1998).**

4. RESULTS AND DISCUSSION

4.1 Quality evaluation of diabetic jam

4.1.1 Chemical and physico-chemical characteristics of Vitrac jam

Table (6) shows the chemical and physic-chemical characteristics of Vitrac jam. The total soluble solids, hydrogen ion concentration and the titreable acidity were found to be 39 %, 3.00 and 0.75 %, respectively. Appendix (4) shows the total sugars of Vitrac jam analyzed by HPLC device, the main reducing sugars were found to be fructose 20.50 % and glucose 23.50 % and non- reducing sugars constitute 0..00 %. The results obtained in this study are well agreed with those reported by the **GSO (2012).** However, the pH of Vitrac was found lower than the specifications and glucose content disagrees with those published by both **British standard specification (2005)** and **GSO (2012).**

4.1.2 Chemical and physico-chemical characteristics of Diet jam

Table (7) shows the chemical and physic-chemical characteristics of Diet jam. The total soluble solids, hydrogen ion concentration and the titreable acidity were found to be 42 %, 3.20 and 0.70 %, respectively. Appendix (5) shows the total sugars of Diet jam analyzed by HPLC device , the main reducing sugars were found to be fructose 42.40 % and glucose 0.00 % and non-reducing sugars constitute about 0.00 %. The results obtained in this study are well agreed with reported by the both **British standard specification (2005)** and **GSO (2012).**

As show in table (8) there was no significant difference in the pH of the tow jams. However the total soluble solids, titreable acidity, glucose, fructose and sucrose were significant difference of the tow jams.

Table (6): The chemical and physico-chemical characteristics of Vitrac jam

Parameter	Value
	n = 3 ± SD
Total soluble solids (T.S.S %)	39.00 ± 0.32
Hydrogen ion concentration (pH)	3.00 ± 0.02
Titreable acidity (%)	0.75 ± 0.01
Glucose (%)	23.50 ± 0.18
Fructose (%)	20.50 ± 0.15
Sucrose (%)	0.00 ± 0.00

Table (7): The chemical and physico-chemical characteristics of Diet jam

Parameter	Value
	n = 3 ± SD
Total soluble solids (T.S.S %)	42.00 ± 0.39
Hydrogen ion concentration (pH)	3.20 ± 0.04
Titreable acidity (%)	0.70 ± 0.01
Glucose (%)	0.00 ± 0.00
Fructose (%)	42.40 ± 0.51
Sucrose (%)	0.00 ± 0.00

Table (8): Comparison between chemical and physico-chemical characteristics of Vitrac and diet diabetic jam

Parameter	Diet	Vitrac	$Lsd_{0.05}$	SE±
	n = 3 ± SD			
Total soluble solids T.S.S (%)	42.00 ± 0.39[a]	39.00 ± 0.32[b]	2.65[*]	0.883
Hydrogen ion concentration (pH)	3.20 ± 0.04[a]	3.00 ± 0.02[a]	0.39[NS]	0.097
Titratable acidity (%)	0.70 ± 0.01[b]	0.75 ± 0.01[a]	0.41[*]	0.136
Glucose (%)	0.00 ± 0.00[b]	23.50 ± 0.18[a]	5.82[**]	1.904
Fructose (%)	42.40 ± 0.51[a]	20.50 ± 0.15[b]	6.76[**]	2.253
Sucrose (%)	0.00 ± 0.00	0.00 ± 0.00	-	-

Means having different superscripts in a row are significantly different (P≤0.05).

Values are mean±SD.

n = number of independent determination.

SD = Standard deviation.

SE± ≡ Overall experiment error.

[*] ≡ Significant at (P≤ 0.05). [**] ≡ highly significant. N.S ≡ not significant

4.1.3 Microbiological characteristics of Vitrac jam

Table (9) shows the microbiological characteristics of Vitrac jam. The total viable count of bacteria, yeasts and moulds, *E. coli* and total coliform were found to be 2.48log^{10} cfu/g , 0.00 log^{10} cfu/g, 0.00 MPN/g and 0.00 MPN/g, respectively. The results obtained in this study are well agreed with those reported by the **SSMO (2006).**

4.1.4 Microbiological characteristics of Diet jam

Table (10) shows the microbiological characteristics of Diet jam. The total viable count of bacteria, yeasts and moulds, *E. coli* and total coliform were found to be 3.22 log^{10} cfu/g, 2.59 log^{10} cfu/g, 0.00 MPN/g and 0.00 MPN/g, respectively. The results obtained in this study are well agreed with those reported by the **SSMO (2006).**

As show in table (11) there was significant difference in the total viable count of bacteria of the tow jams.

Table (9): The microbiological characteristics of Vitrac jam

Test	Value
	n = 3 ±SD
Total viable count of bacteria (log^{10} cfu/g)	2.48 ± 0.00
Yeasts and moulds (log^{10} cfu/g)	-
E. coli (MPN/g)	0.00 ± 0.00
Total coliform (MPN/g)	0.00 ± 0.00

Table (10): The microbiological characteristics of Diet jam

Test	Value
	n = 3 ±SD
Total viable count of bacteria (log^{10} cfu/g)	3.22 ± 0.64
Yeasts and moulds (log^{10} cfu/g)	2.59 ± 0.11
E. coli (MPN/g)	0.00 ± 0.00
Total coliform (MPN/g)	0.00 ± 0.00

Table (11): Comparison between microbiological characteristics of Vitrac and diet diabetic jam

Parameter	Diet	Vitrac	$Lsd_{0.05}$	SE±
	n = 3 ± SD			
Total viable count of bacteria (log^{10} cfu/g)	3.22 ± 0.64[a]	2.48 ± 0.00[b]	0.718[*]	0.239
Yeasts and moulds (log^{10} cfu/g)	2.59 ± 0.11	-	-	-
E. coli (MPN/g)	0.00 ± 0.00	0.00 ± 0.00	-	-
Total coliform (MPN/g)	0.00 ± 0.00	0.00 ± 0.00	-	-

Means having different superscripts in a row are significantly different (P≤0.05).

Values are mean±SD.

n = number of independent determination.

SD = Standard deviation.

SE± ≡ Overall experiment error.

[*] ≡ Significant at (P≤ 0.05). [**] ≡ highly significant. N.S ≡ not significant

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the results obtained in this study it was found that, the diabetic jam (Diet) has low calorie content and free from sugars. Therefore it can not increase the level of sugars in the blood. It is suitable for diabetic patients and people who want to reduce their weight.

Vitrac jam has high content of glucose. Therefore it can be increase the level of sugars in the blood. Therefore it can not suitable for diabetic patients.

5.2 Recommendations

1. Diet jam can be use therefore it can not increase the level of sugars in the blood. It is suitable for diabetic patients and people who want to reduce their weight.
2. Vitrac jam has high content of glucose. Therefore it can be increase the level of sugars in the blood. It is not suitable for diabetic patients and people who want to reduce their weight.
3. Modernization of the food control act 1973.
4. Establishing standard specifications of special food for diabetics by SSMO.
5. Manufacturing of diabetic jam on local scale in Sudan.
6. Increase inspection of special food for diabetic patients.
7. Further studies are definitely needed to ensure safety, storage conditions, shelf-life, economic feasibility and the market demands for the product.

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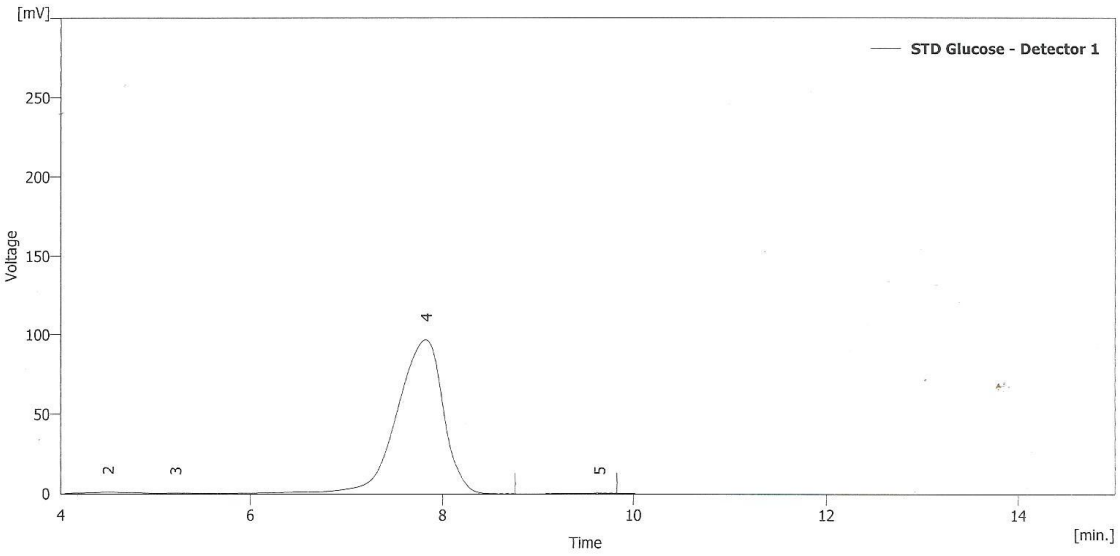
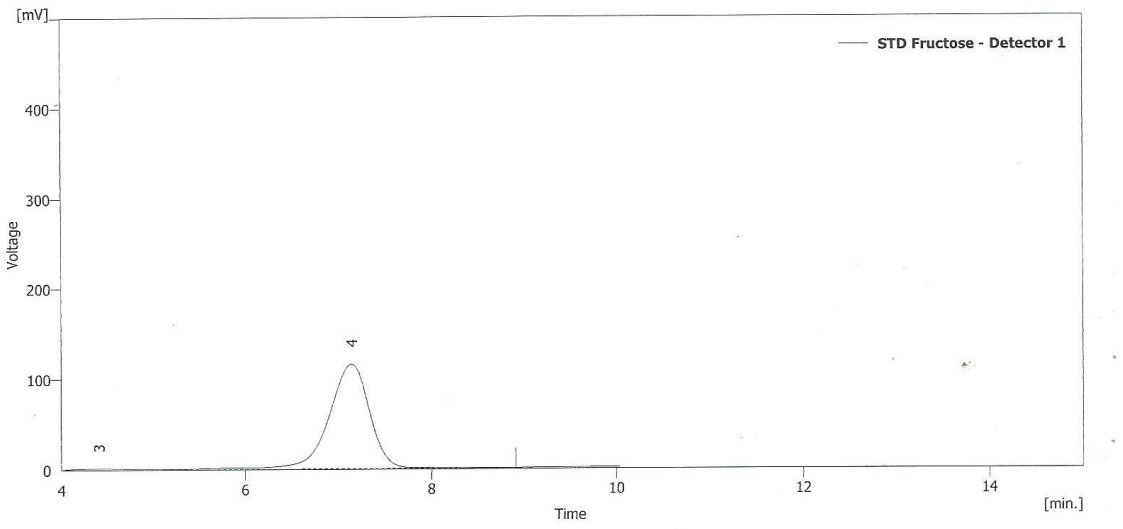
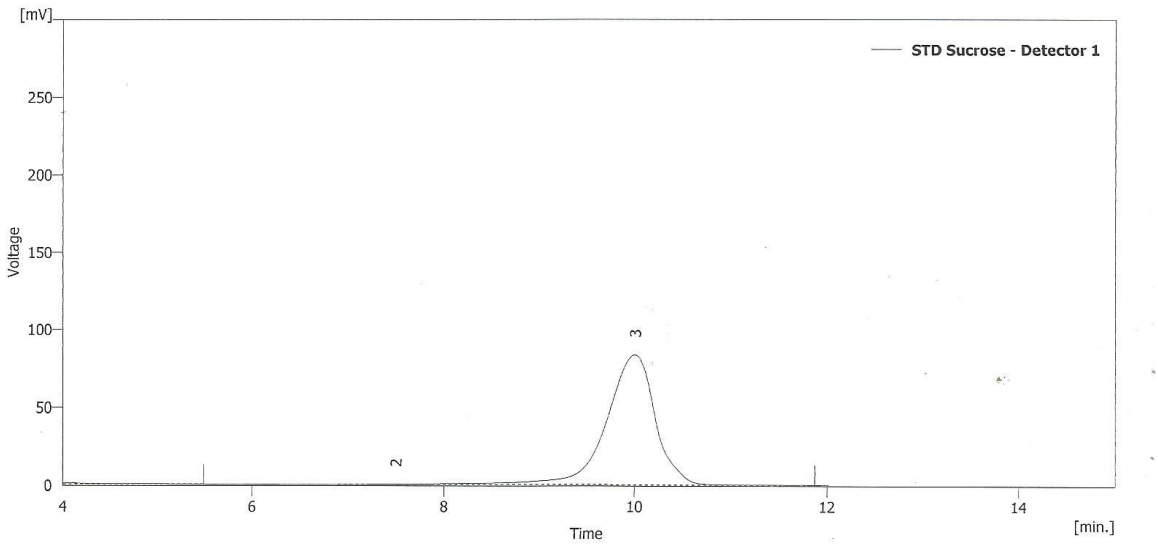


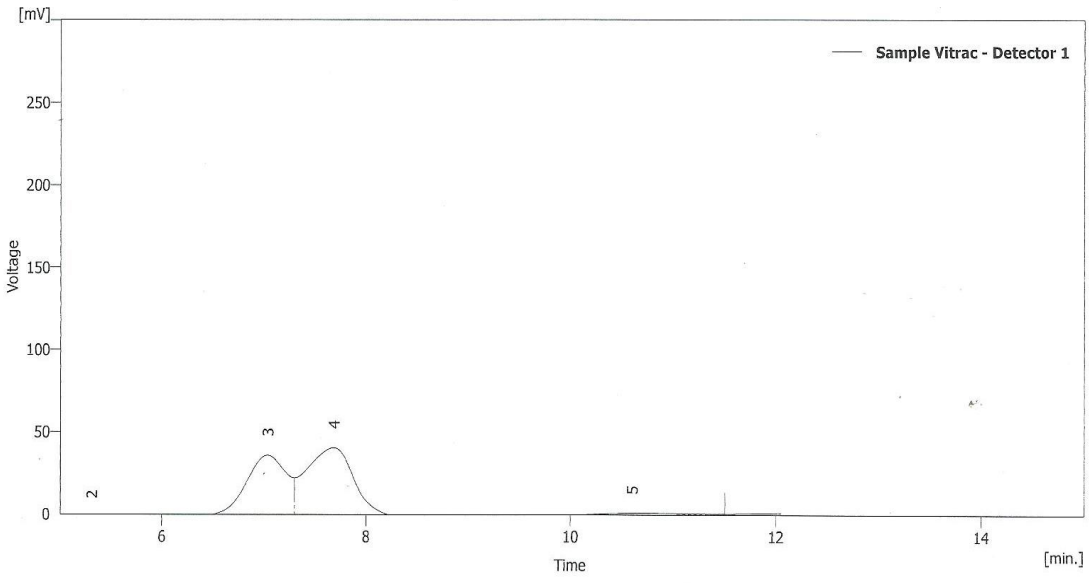
Appendix (1): Concentration of Glucose Standard



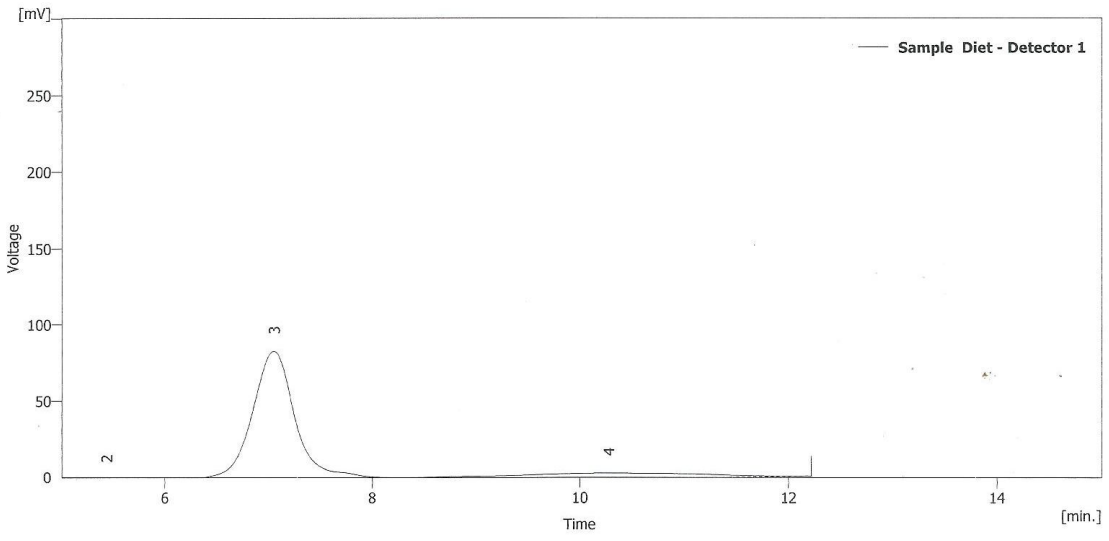
Appendix (2): Concentration of Fructose Standard



Appendix (3): Concentration of Sucrose Standard



Appendix (4): Concentration of Vitrac Jam Sample



Appendix (5): Concentration of Diet Jam Sample