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Sudan university of Science and Technology

College of Agricultural Studies

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Quality evaluation of stirred yogurt supplemented with Guddaim Fruit *(Grewia tenax)*

تقييم جودة الزبادي المخلوط المدعم بفاكهة القضيم

A dissertation submitted to Sudan University of Science and Technology in partial fulfillment of the requirements of the degree of B.Sc. (Honours) in food science and technology

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DEDICATION

To our families

to our teachers

and to our friends

with respect.

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Prayers and thanks to **ALLAH** who gave our good health and support to accomplish this study.

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TABLE OF CONTENTS

Title **Page No.**
إستهلال..... **Error! Bookmark not defined.**
DEDICATION..... I
ACKNOWLEDGEMENTS II
TABLE OF CONTENTS..... III
LIST OF TABLES..... VI
LIST OF FIGURES VII
LIST OF APPENDICES..... VIII
ABSTRACT IX
ملخص الدراسة..... X
CHAPTER ONE 1
INTRODUCTION 1
CHAPTER TWO 3
LITERATURE REVIEW 3
2.1 Guddaim..... 3
2.1.1 Taxonomy..... 3
2.1.1.1 Scientific classification 3
2.1.1.2 Common names 3
2.1.2 Botanical description 4
2.1.3 Geographical distribution..... 4
2.1.4 Ecology 5
2.1.5 Main uses..... 5
2.1.5.1 Common uses 5
2.1.5.2 Folkloric uses..... 6
2.1.5.3 Ethnomedical uses 7
2.1.5.4 Medicinal uses 7
2.1.6 Nutritional value 7
2.2 Yogurt 9

2.2.1 Definition 9
2.2.2 Yogurt starter culture 10
2.2.3 Health benefit of yogurt 10
2.2.4 Manufacturing of yogurt 13
2.2.4.1 Main processing steps of yogurt making 13
2.2.4.1.1 Milk standardization 13
2.2.4.1.2 Homogenization 15
2.2.4.1.3 Heat treatment 15
2.2.4.1.4 Fermentation 17
2.2.4.1.5 Cooling 17
2.2.5 Shelf life of yogurt 19
2.2.6 Factor effecting the quality of yogurt 19
2.2.7 Types of yogurt 19
2.2.7.1 Fruit yogurt 20
2.2.7.1.1 Preparation of fresh fruit 21
2.2.8 The nutritional value of yogurt 22
CHAPTER THREE 25
MATERIALS AND METHODS 25
3.1 Materials 25
3.2 Methods 25
3.2.1 Preparation of fruit juice 25
3.2.2 Manufacture of yogurt 26
3.2.3 Chemical determination of Guddaim fruits 26
3.2.3.1 Moisture content 26
3.2.3.2 Protein content 26
3.2.3.3 Fat content 27
3.2.3.4 Fiber content 28
3.2.3.5 Ash content 29
3.2.3.6 Available carbohydrates content 29
3.2.3.7 Minerals content 29
3.2.4 Chemical determination of Guddaim yogurt 30
3.2.4.1 Determination of fat, protein and total solids 30

3.2.4.2 Determination of ash....30
3.2.5 Physicochemical determination....30
3.2.5.1 Determination of pH....30
3.2.5.2. Determination of Titratable Acidity of Guddaim yogurt....31
3.2.5.3 Acidity of Guddaim juice....31
3.2.5.4 Determination of brix....31
3.2.5.5 Determination of viscosity of Guddaim yogurt....32
3.2.6 Microbiological analysis....32
3.2.6.1 Preparation of media....32
3.2.6.2 Types of culture media used for micro biological examination of stirred yogurt:....32
3.2.6.2.1 Violet red bile agar (Merck)....32
3.2.6.2.2 Standard plate count agar (Merck)....33
3.2.6.3. Preparation for plating....33
3.2.6.3.1 Sterilization of equipments....33
3.2.6.3.2 Plating method....33
3.2.7 Sensory evaluation method....34
3.2.8 Statistical analyses....35
CHAPTER FOUR....36
RESULTS AND DISCUSSION....36
4.1 Proximate composition of Guddaim....36
4.2 Proximate composition (%) and energy content of yogurt treated with Guddaim....36
4.3 Physicochemical properties of yogurt treated with Guddaim....37
4.4 Microbiological load of yogurt treated with Guddaim:....38
4.5 Minerals content (mg/100g) of yogurt treated with Guddaim....49
4.6 Sensory evaluation of yogurt treated with Guddaim....49
CHAPTER FIVE....56
CONCLUSIONS AND RECOMMENDATIONS....56
5.1 Conclusions....56
5.2Recommendations....56
REFERENCES....57
APPENDICES....63

LIST OF TABLES

Table No. **Title** **Page No.**
Table 1: Time-temperature combinations for milk pasteurization process: 17
Table 2: Nutritional composition of different varieties of yogurt (Per 100 g): 22
Table 3: pannel test form 35
Table 4: Proximate composition of Guddaim.....39
Table 5: Proximate composition (%) and energy content of yogurt treated with Guddaim. 40
Table 6: Physicochemical properties of yogurt treated with Guddaim....45
Table 7: Microbiological load of yogurt treated with Guddaim.....51
Table 8: Minerals content (mg/100g) of yogurt treated with Guddaim...53
Table 9: Sensory evaluation of yogurt treated with Guddaim.....54

LIST OF FIGURES

Figure No. **Title** **Page No.**
Figure 1: The production steps in manufacture of stirred and set yogurt are illustrated by (Lee and Lucey, 2010). 18
Figure 2: Moisture content of yoghurt supported with Guddaim 41
Figure 3: Crude protein of yoghurt supported with Guddaim 41
Figure 4: Crude protein of yoghurt supported with Guddaim 42
Figure 5: Fat content of yoghurt supported with Guddaim 42
Figure 6: Ash content of yoghurt supported with Guddaim 43
Figure 7: Carbohydrates of yoghurt supported with Guddaim 43
Figure 8:energy value of yoghurt supported with Guddaim 44
Figure 9: pH-value of yoghurt supported with Guddaim 46
Figure 10: Titratable acidity of yoghurt supported with Guddaim 46
Figure 11: Viscosity of yoghurt supported with Goddaim 47
Figure 12: total solids of yoghurt supported with Guddaim 47
Figure 13: brix° of yoghurt supported with Guddaim 48
Figure 14: total viable count of bacteria of yoghurt supported with Guddaim 52
Figure 15: yeasts and moulds of yoghurt supported with Guddaim 52
Figure 16: Sensory evaluation of yoghurt supported with Guddaim 55

LIST OF APPENDICES

Appendix No.	Title	Page No.
Appendix 1: Guddaim shrub		63
Appendix 2: *Grewia tenax* fruits		63
Appendix 3: *Grewia tenax* natural growth.		64
Appendix 4: *Grewia tenax* distribution		64
Appendix 5: Food Scan apparatus		65
Appendix 6: Titroline		66
Appendix 7: Thermomixer		66
Appendix 8: Guddaim soaking		67
Appendix 9: Balance		67
Appendix 10: pH meter		68
Appendix 11_a: Samples of Guddiam Yogurt		68
Appendix 11_b: Samples of Guddiam Yogurt		69
Appendix 12: Guddiam juice		70
Appendix 13: Sensory evaluation		70

ABSTRACT

This study was conducted to evaluate the quality of stirred yogurt supplemented with Guddaim fruit. milk was analyzed to ensure it does not contain any foreign material, and premigum xly-12007-DD Stabilizer was added (0.2% w/v), skim milk powder fat was 0.8%,solids non-fat 95.2% and total solids 96%. Followed pasteurizing at 90^0C for 15 min ,cooling rapidly to 45^0C . After inoculation with 3% (v/v) yogurt culture of *Lactobacillus delbrueckii subsp bulgaricus* and *Streptococcus thermophilus* incubation was carried out at 45^0C for 3 hr, followed by breaking the curd and addition of fruit juice [10% v/v (T_1), 15% v/v (T_2) and 20% v/v (T_3)], in addition to control (C). Yogurt was stored at 4^0C for one day and chemical, physicochemical, microbiological, minerals and sensory characteristics were carried out. Results indicated that addition of Guddaim did not increase the chemical, physicochemical properties of yogurt in comparison to control.TVBC were high in control ,while coliform bacterial count was nill in all samples and yeasts and moulds count was high in T_2 and T_3 but in T_1 was nill. The taste and consistency were best in control judged by panelists while flavor ,after taste and overall acceptability were best in T_3 and the color was best in T_2.

ملخص الدراسة

هدفت هذه الدراسة الى تقويم جودة الزبادي المخلوط المدعم بثمرة القضيم ،تم تحليل الحليب للتأكد من خلو المحتوى من اي مواد غريبة ،واضافة المثبت premigum xly-12007-DD بنسبة ٢% ،بدرة الحليب منزوعة الدسم بنسبة دهن ٨.% ،المواد الصلبة غير الدهنية بنسبة ٩٥.٢% ومواد صلبة كلية بنسبة ٩٦%.

تمت البسترة عند ٩٠˚ م لمدة ١٥ ثانية ثم التبرد بسرعة عند ٤٥˚ م وتم التحضين بعد إضافة ٣% من البادئ *Lactobacillus delbrueckii subsp bulgaricus* and *thermophilus Streptococcus* عند ٤٥˚ م لمدة ٣ ساعات وتم تكسير الخثرة بإضافة عصير الفاكهة (١٠% ل T_1 ،١٥% ل T_2 ٢٠% ل T_3) ،بالإضافة للعينة الضابطة.حفظ الزبادي عند ٤˚ م لمدة يوم واحد وأجريت تحاليل الخصائص الحسية ،الكيميائية،الفيزوكيميائية المعادن،الميكروبيولوجية له.قادت نتائج إضافة القضيم إلى عدم وجود زيادة في الخصائص الكيميائية والفيزوكيميائية للزبادي المعامل مقارنة مع العينة الضابطة .التعداد الكلي للبكتريا كان عاليا في العينة الضابطة بينما بكتريا القولون غير موجودة في كل العينات،أعداد الخمائر والأعفان وجد عاليا في T_3 و T_2 إلا انها لم توجد في T_1 .الطعم والقوام للزبادي أفضل في العينة الضابطة تبعا لحكم المتذوقين،بينما النكهة والطعم مابعد التذوق والقبول العام هي الأفضل في T_3 واللون هو الأفضل في T_2.

CHAPTER ONE

INTRODUCTION

Yogurt is defined as a coagulated milk product obtained by the fermentation of lactose into lactic acid through the action of *Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus thermophilus* from milk with or without additions **(Trachoo, 2002).**

Yogurt is a valuable health food for infants and elderly people, and the nutritional constituents of yogurt are derived from the milk used in the manufacture, in addition to those synthesized by the lactic acid bacteria and those added by the manufacturers **(Ayar *et al.*, 2006).**

The consumption of yogurt has been associated with health benefits which include protection against gastrointestinal upsets, enhancing lactose digestion by maldigesters, decreasing risk of cancer, lowering blood cholesterol, improving immune response, helping the body to assimilate protein, calcium and iron, longevity, diarrhea protection and control as well as maintenance of gastrointestinal microflora **(Aly *et al.*, 2004; Foda *et al.*, 2007; Iwalokun and Shittu, 2007; Vahed *et al.,* 2008; Andronoiu *et al.,* 2011**).

The benefits of yogurt consumption to gastrointestinal function are most likely due to effects mediated through gut microflora, bowel transit, enhancement of gastrointestinal innate and adaptive immune responses **(Adolfsso *et al.*, 2004).**

Consumers, especially children, demand novel yogurt formulations more than traditional ones like plain yogurt. Introduction of various fruit-flavored yogurt has significantly contributed to the consumption of

yogurt from all ages. A variety of different flavoring ingredients (fruits, natural flavors or synthetic flavors) are currently added to yogurt. The types of flavoring materials used are fruits, fruit preserves, canned fruits, frozen fruits and miscellaneous fruit products (Küçük ner and Tarakçi, 2003). Most common fruits used in yogurt formulae are peach, cherry, orange, lemons, purple plum, boysenberry, spiced apple, apricot, pineapple, strawberry, raspberry and blueberry **(Cinbas and Yazici, 2008).**

Grewia tenax (Forssk.) Fiori (locally known as Guddaim) is a fruit producing deciduous shrub or small tree of widespread occurrence in the semi-arid and sub-humid tropical zones of the Sudan **(Gebauer *et al.*, 2007).**

The Guddaim fruit contents of moisture, ash, fat, fiber, protein and carbohydrate **(Abdualrahman *et al*, 2011).**The fruit is rich in iron, potassium ,sulphur, phosphorus, magnesium, calcium and sodium, and a good source of amino acids(aspartic acid, serine, glutamic acid, alanin, valin cysteine, methionine, leucine, tyrosine, lysine, histidine and arginine).The fruit is traditionally used for the treatment of anemia **(Gebauer *et al.*, 2007; Mohammed El Hassan and Yagi, 2010).**

Main objective:

To produce yogurt of high quality with added Guddaim fruit.

Specific objectives:

1- To determine proximate chemical composition of Guddaim yogurt.
2- To determine minerals.
3- To determine microbiological characteristic of Guddaim yogurt.
4- To evaluate the sensory properties.

CHAPTER TWO

LITERATURE REVIEW

2.1 Guddaim

2.1.1 Taxonomy

2.1.1.1 Scientific classification

Kingdom	:	Plantae
Division	:	Angiospermae
Sub-division	:	Dicotyledons
Class	:	Polypetalae
Series	:	Thalamiflorae
Order	:	Malvales
Family	:	Tiliaceae
Genus	:	Grewia
Species	:	tenax

(WAFC, 2006).

2.1.1.2 Common names

(Arabic): gaddeim, gaddein, godem, umm ageda.
(Somali): damak, defarur, dekah, duferu.
(Wolof): kel.
(Ethiopia): Fo(Afargna), Lenkoata (Amargna), Bururi, Dhoqonu, Lensa (Oromiffa),Quetata (Agonia).

In india: gangu Kanger, gangerum, gango, gundu Kadira Kadadari, Kaladi,achchu **(WAFC,2006)**.

2.1.2 Botanical description

Grewia tenax is a multistemmed small shrub up to two meters tall usually rounded but generally battered and untidy due to browsing. Bark is smooth,grey, and very fibrous so that twigs are hard to break. The leaves are oval and the tip is pointed or rounded. The edge of the leave is toothed. The vein network is very clear below. Alternate, almost circular in outline, 1.5 - 4 cm in diameter, Margins toothed and prominently tri-nerved at the base, Stipules are conspicuous, up to 4mm. long, filiform, pubescent, falling early. The young shoots and the flowers are covered with red – brown hairs. The flowers are yellow, purple of white, solitary or in twos or fours axillary placed in a terminal head about 5cm. long, the central flowers opening first, with many stamens in the center. Petals are white, about 1cm long, but usually much less, pubescent, with a linear and often 2- dentate lamina almost as long as the sepals and narrower than the basal nectariferous claw which is circumvillous within ledged above and up to 1.5 mm long; Sepals long and recurved.16 The fruit is orange - red at maturity, with 1- 4 spheroid lobes each rounded and fleshy about 5mm across **(WAFC, 2006)**.

2.1.3 Geographical distribution

The plant is native of Algeria ,Botswana ,Chad ,Djibouti ,Ethiopia ,Iran ,Kenya ,Mali ,Mauritania ,Morocco ,Namibia, Niger ,Nigeria ,Saudi Arabia ,Senegal ,Somalia ,South Africa ,Sudan ,Tanzania ,Uganda ,Zimbabwe . The plant species is exotic to India and Pakistan .In India it is spread over Andhra ,Bihar ,Gujarat ,Haryana ,Karnataka ,Kerala ,Pradesh ,Maharashtra ,Punjab ,Rajasthan ,Tamil Nadu and west Bengal **(ELamin,1985).**

2.1.4 Ecology

Grewia tenax is highly drought resistant and occurs in the driest savannas at desert margins and regions of higher rainfall, where it grows in thicket on termite mounds in other wise seasonally flooded country. In the sahel it growth in rocky place on hills and slopes, in regions with 100-600 mm of rain per annul **(Orwa *et al*., 2009)**.

Guddaim (*Grewia Tenax*) is one of the valuable plant species in Sudan .It is largely spread in arid area such as sand and near mountains, especially in savanna plantation area at the northern and the meddle of Sudan. Reported about Guddaim growth destinations and it has adisctinations and it has discontinuous availability at arid area in India, Elgezira southern area, and the eastern of Africa. Guddaim plant requires 200mm of seasonal rainfall and it is well resistant to soil salinity and it is productively is about 1500 grain per kg **(FAO, 1988)**.

2.1.5 Main uses

2.1.5.1 Common uses

-Food: the fruits consumed by man and animals contain a large amount of iron and can be made into are fleshing drink, Fruit storage can be extended by drying .The dead leaves are eaten, but only while they remain on the plant .Its fruits are thirst quencher in summer season .A drink is prepared by soaking the fruit overnight, hand-pressing, sieving, and sweetening.

-Fodder: Young leaves are consumed by livestock, they are slightly palatable at the end of dry seasons, and have fairly good feed value.

-Fuel: The branches are uses as firewood, and can be used in charcoal making.

-Fiber: Lingo-cellulosic fiber with good tensile strength is made by the bark, which is used to make ropes and for binding purposes in house construction.

-Timber: *G .tenax* wood is used in making weapons such as clubs, bows, arrows, and for other general purposes.

-Poison: A mucilaginous bark preparation is used by women against hair vermin **(ALgazali *et al*., 1997).**

2.1.5.2 Folkloric uses

In Sudan: *G. tenax* grows in Kordofan region (Northern and Southern). The fruits are eaten fresh or dried for later consumption. A drink is prepared by soaking the fruit overnight, and then hand – pressed, sieved, and sweetened. Porridge, called (Nesha), is also prepared from this drink by the addition of custard and flour then given to mothers to improve their health and lactation .In India the orange fruit is usually eaten raw, and leaves are boiled and eaten as vegetable. In Ethiopia the ripe fruit is collected and eaten raw either as a whole or chewed and only the sweet juice is swallowed, the fruits are always collected and consumed between September and April, the leaves are also used as animal fodder and the wood can be used as firewood and for construction purposes (local construction and farm tools). The bark is sometime used to produce local ropes for construction purposes. The fruit contains a large amount of iron. Fruit storage can be extended by drying, the dead leaves are eaten but only while they remain on the plant. A mucilaginous bark preparation is used by women against hair vermin **(Famine Foods, 1998)**

2.1.5.3 Ethnomedical uses

(**Anttila *et al*., 1993)** in Kenya studied preference and chemical composition of ten indigenous woody plant species used as livestock fodder included *Grewia tenax*. They concluded that milk production and reproduction of cattle and small stock had increased by eating these plants and leaves of *G. tenax*, which had the highest protein content (24.91%). Bees visit the flowers of *G.tenax* for pollen and nectar. In Kenya plant parts are used as a remedy for colds and chest complaints and also as a chief constituent in Typhoid remedy **(Von Maydell, 1986)**.

2.1.5.4 Medicinal uses

G.tenax (Guddaim) is wide spread in northern Kordofan ,central Sudan and the southern part of the country .In these areas of Sudan the powdered roots are used for tonsillitis and throat infections **(Elghazali *et al* ., 1997)**.Root preparations are also used against tuberculosis and other chest diseases **(Neuewinger,2000)**. The bark extract is purgative and is generally used as anthelmntic and against many intestinal parasites **(Neuewinger, 2000)**. Roots are used to treat jaundice, pulmonary infection asthma. Leaves are used against trachoma. Decoction and fruit juice are used for their tonic and anti-anemic proprieties .Fruits are small berries ,round ,orange .Sweetened and it may be consumed either fresh or dry **(Bowden,1978)**.

2.1.6 Nutritional value

The Guddaim fruits contain about 25% D-Fructose ,15mg/100g ascorbic acid ,25mg /100g iron ,40mg/100g calcium,6.3% protein ,0.4%fat ,8.1%cred fiber ,4.5%ash ,15.1%starch ,1.6% sucrose and 21.0%D-glucose **(Orwa *et al*., 2009)**.

In other study the nutritional value of Guddaim fruits, seeds and pulps was carried out, the contents of moisture, ash, fat, fiber, protein and carbohydrate were 7.20%, 3.50%, 0.13%, 14.0%, 8.20%, 66.97%, 7.30%, 3.0%, 0.92%, 14.85%, 7.5%, 66.43% and 7.60%, 3.30%, 0.10%, 13.60%, 8.80% and 66.6% for the fruits, seeds and pulps, respectively. Guddaim fruits were found to contain about 25.5% D-fructose, 15mg/100g ascorbic acid, 25 mg/100g iron and 40 mg/100g calcium **(Abdualrahman *et al.*, 2011)**.

The chemical analysis and nutritional properties of Guddaim fruits were investigated. Proximate compositions, total energy, minerals, vitamins, sugar profile, amino acids and volatile compounds were determined. Content of carbohydrate was 66.59%, while moisture, crude fiber, ash, crude protein and crude fat were 11.72%, 9.41%, 4.12%, 7.68% and 0.48%, respectively. The calorific values of fat, protein, and carbohydrates were 0.043, 0.307, and 2.663 kcal/g; respectively. The content of potassium was the highest minerals (856.25 mg/100 g), while chromium was the lowest (0.063 mg/100 g). The main amino acids were threonine , valine , phenylalanine and Lucien 1.99, 2.91, 2.77, 3.62 g/100 g, respectively, which were found to be higher than the level of Daily Recommended Allowance (DRA) of essential amino acids required for child and adult human suggested by FAO/WHO/UNU pattern. Thiamine, riboflavin, pyridoxine, ascorbic acid and folic acid were, 0.185, 0.205, 3.15, 0.415 and 0.765 mg/100 g, respectively. The highest content of sugar was glucose 115.734 mg/g. Volatile compounds were identified to be relatively smaller, that is ; acetic acid 61.04%; hydrazine –methyl 4.78%; 2,3butanediol4.06%and hexanoic acid 3.48% (**Mire *et al*.,2003).**

In other study the nutritional value of Guddaim fruits moisture, protein, fat , fiber , total sugar , reducing , non reducing sugar ,ash and minerals(iron, calcium) contents are 5.3-11.64 ,6.3-7.8,0.1-0.4,8.1-14.3,17.6,44.6--39.6,1.6-1.8,4.4-4.7 and(7.4,610mg/100g). The results following this study showed this fruit contained a lot of important nutrients and nutritional value, beneficial to human health (**El-amin, 1995).**

2.2 Yogurt

2.2.1 Definition

Yogurt is defined as a coagulated milk product obtained by the fermentation of lactose into lactic acid through theaction of *Lactoacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* from milk with or without additions **(Trachoo, 2002)**.

Yogurt is a product made from heat treated milk that may be homogenized prior to the addition of lactic acid bacteria (LAB) cultures containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (**Code of Federal Regulations Section 131.203, 2011**). **Similarly, (Tamime,2002).**

Yogurt is product being manufactured from milk-with or without the addition natural derivate of milk, such as skim milk powder, whey concentrates caseinates or cream-with a gel structures those results from the coagulation of bacteria culture. Furthermore, these bacteria must be "viable and abundant" at the time of consumption **(Serra *et a*l.,2009).**

2.2.2 Yogurt starter culture

Micro-organisms are important in dairy product .One of the most important groups of acid product bacteria in the food industry is the lactic acid bacteria (LAB) which are balance for starter culture for dairy products .The proper selection and balance for starter culture is critical for the manufacture of fermented products of desirable texture and flavor **(Adib and Bertr 2009).**

2.2.3 Health benefit of yogurt

Yogurt is a valuable health food for infants and elderly people, and the nutritional constituents of yogurt are derived from the milk used in the manufacture, in addition to those synthesized by the lactic acid bacteria and those added by the manufacturers **(Ayar *et al.*, 2006)**.

The consumption of yogurt has been associated with health benefits which include protection against gastrointestinal upsets, enhancing lactose digestion by maldigesters, decreasing risk of cancer, lowering blood cholesterol, improving immune response, helping the body to assimilate protein, calcium and iron, longevity, diarrhea protection and control as well as maintenance of gastrointestinal microflora **(Aly *et al.*, 2004; Foda *et al.*, 2007; Iwalokun and Shittu, 2007; Vahed *et al.,* 2008; Andronoiu *et al.,* 2011).**

The benefits of yogurt consumption to gastrointestinal function are most likely due to effects mediated through gut microflora, bowel transit, enhancement of gastrointestinal innate and adaptive immune responses. The nutrient composition of yogurt is based on the nutrient composition of the milk from which it is derived, which is affected by many factor, such as genetic and individual mammalian differences, feed, stag of

lactation, age, and environmental factors such as the season of the year. Other variable that play a role during processing of milk ,including temperature ,duration of heat exposure ,exposure to light ,and storage condition ,also affect the nutritional value of final product . In addition, the changes in milk constituents that occur during lactic acid fermentation influence the nutritional and physiologic value of the finished yogurt. The specific health benefits depend on the strain and viability of the culture in yogurt, the source and type of milk solids that may be added before fermentation, and the temperature and duration of the fermentation process**(Adolfsso *et al.*, 2004)**.

Yogurt is considered as healthy food due its high digestibility and bioavailability of nutrient and also can be recommended to the people with lactose intolerance ,gastrointestinal disorder such as inflammatory bowel disease and irritable bowel disease ,and aids in immune function and weight control ,because of these health benefits associated with yogurt consumption ,there is an increasing trend for yogurt and is the fastest growing dairy category in the market in particular ,standard yogurt and yogurt drinks. Yogurt is more nutritive than milk in vitamin content for its digestibility .It is also used as sources of calcium and phosphorous .It is believed that yogurt has valuable "therapeutic properties" and helps in curing gastrointestinal disorder .Yogurt may aid digestion ,ease diarrhea ,boost immunity and protect against cancer **(O'sulliva *et al.*,1992).**

Being nutritionally rich in protein, calcium, riboflavin, and vitamin B6, and vitamin B12, yogurt is considered to have more nutritional benefits than milk**.**

Benefits of (LAB) bacteria in yogurt on the gastrointestinal function and health yogurt and (LAB) bacteria contribute to several factors that enhance the gut function and health .The make of gastrointestinal flora ,the immune response against pathogens .Gut micron flora play a major role against exogenous infectious bacteria through colonization resistance .Most of the bacteria that cross the barriers stomach and small intestine well be live ,metabolically active and colonized with in the gut ecosystem **(Chandan and Kilara,2013).**

Yogurt or yoghurt is one of the most popular fermented dairy products worldwide which has great consumer acceptability due to its health benefits other than its basic nutrition. In general, yogurt is considered as a nutrition-dense food due to its nutrient profile and is a rich source of calcium that provides significant amounts of calcium in bio-available form. In addition, it provides milk proteins with a higher biological value and provides almost all the essential amino acids necessary to maintain good health. Yogurt is considered as a pro-biotic carrier food that can deliver significant amounts of pro- biotic bacteria into the body which can claim specific health benefits once ingested. These are usually marketed as bio-yogurt. Moreover, yogurt is reported to claim improved lactose tolerance, immune enhancement and prevention of gastrointestinal disorders, because of these known health benefets of yogurt, consumer demand for yogurt and yogurt related products has been increased and became the fastest growing dairy category in the global market. Yogurt are now being manufactured in a numerous styles and varieties with different fat contents, flavors and textures suitable for different meal occasions and plates as a snack, dessert, sweet or savory food **(O'sulliva *et al.*, 1992).**

2.2.4 Manufacturing of yogurt

Manufacturing of yogurt is an ancient technique, which dates back to thousands of years, and the knowledge has transferred generation to generation. However, during the last few decades, it became more rational due to improvement of various fields such as microbiology, biochemistry and food engineering. Today it is a complex activity combined with art and science. The generalized process of yogurt making is comprised of modifying the original composition of milk, pasteurizing the yogurt mix, fermentation at thermophilic temperatures (40-45^{0}C), cooling and addition of fruits and flavors. The process of yogurt making is an ancient craft which date back thousands of years, and over the last few decades the process has become more rational due to improvements in such disciplines as microbiology, engineering and chemistry **(Tamime ,Robinson,1999)**.

2.2.4.1 Main processing steps of yogurt making

The main processing steps in the manufacture of this product include milk standardization, heat treatment, homogenization, addition of starter culture and fermentation, next cooling and finally storage of end product .many other processing steps (e.g. Addition of sugar or fruit) practiced for some products **(Lucey, 2002)**.

2.2.4.1.1 Milk standardization

In yogurt production we have to consider important basics in manufacture, that is the fat content should be standardized to the level preferred by the market, and also the total solid is often being increased by adding dried skim milk, condensed milk or skim milk or liquid milk

.and the increase in the milk solids is to get amore firm coagulum **(Shori and Baba, 2012)**

Milk solid content of yogurt seems to be varied from 14-15% in commercial yogurt products and the minimum milk solids nonfat content varies from 8.2-8.6% according to the standards and regulations of many countries **(Tamime and Robinson, 1999)**.

According the Codex Alimentarius Commission yogurt should have a minimum protein content of 2.7% and a maximum fat content of 15% **(CAC, 2010)**.

In order to achieve this, the FAO/WHO standards specifies that milk should be standardized with the minimum SNF and milk fat content of 8.2% and 3% respectively for yogurt manufacture. The average composition of bovine milk comprised of 4.5%lactose, 3.3% protein, 3.5% of fat and 0.7% mineral matter .Therefore, it is obvious that the composition of yogurt is varied according to the variety, and yogurt mixture should therefore standardize accordingly in such a way that produce an end product with not less than 2.7% of protein and less than 15% of milk fat with a titratable acidity not less than 0.3% expressed as percentage of lactic acid **(CAC, 2010)**.

Stabilizers such as pectin and gelatin are added to the yogurt mix in order to attain the characteristic properties of yogurt namely, texture, mouth feel ,appearance, viscosity and to inhibit the whey separation **(Tamime and Robinson,1999)**,**(Lee and Lucey,2010)**. However, both over-stabilization and under-stabilization may cause quality defects as the over-stabilization results a“jello-like”springy body of yogurt, whereas the

under-stabilization causes “runny body” or whey separation **(Lee and Lucey, 2010)**.

2.2.4.1.2 Homogenization

Homogenization treatment reduces the diameter of fat globules to less than 1μm and ensures uniform distribution throughout the food matrix, thus considered as an important processing step especially for yogurt with high fat content. Consequently, it results no distinct creamy layer on surface of the yogurt and improves consistency of the yogurt. Homogenization is accomplished by using a homogenizer or viscolizer where the milk is forced through small openings at a high pressure in which the fat globules are broken up due to the shearing forces. Typically, milk is homogenized using pressures of 10-20 and 5 MPa in first and second stages, respectively for over 10-17 min **(Lee and Lucey, 2010)**.

More recently, ultra-high pressure homogenization has been introduced to the commercial yogurt manufacture leading to an increase in yogurt firmness and water holding capacity comparatively to that of the conventional homogenization process**(Serra, *et al.*,2009) ,(Serra ,*et al.*,2008)**.

2.2.4.1.3 Heat treatment

It is generally considered that the heat treatment of milk is an essential step in yogurt manufacturing process that greatly influences the microstructure and physical properties of yogurt .Heat treatment has a number of beneficial effects as it will destroy the microorganisms present in milk or yogurt mixture which can potentially interfere with the controlled fermentation process, will denature the whey proteins that will

give the final product a better body and texture, and will release the compounds in milk that stimulate growth of the starter culture microorganisms. In addition, it will help some ingredients to achieve the required state to form gels and protein lattice, that affects the final texture and viscosity of the product while aids in removing dissolved oxygen in the milk and thereby assists the starter culture growth as they are sensitive to oxygen **(Lee and Lucey, 2010)**.

Heat treatment is a continuous- or batch-process involves heating of milk to relatively high temperature and hold in there for pre-determined time period. The time-temperature combinations for the batch heat treatments that are commonly employed in the commercial yogurt making include 85^0C for 30 min and 90-95^0C for 5 min .Alternative time-temperature combinations available for the milk pasteurization are summarized in the Table1. Despite the time-temperature combination used, it is a must to fulfill the minimum requirement to destroy the most heat resistant pathogen currently recognized in milk, *Coxiella burnetii* that cause Q-fever in human .Heat treatment of milk is important to destroy unnecessary pathogenic organisms and enzymes present in milk **(Tamime and Robinson, 1999)**.

Table 1: Time-temperature combinations for milk pasteurization process:

Type of holding pasteurization	Process	Temperature (^{0}C)	Time
Low temperature Long time (LTLT)	Batch	62.8	30min
High temperature Short time (HTST)	Continuous	71.7	15s
Higher Heat Shorter Time (HHST)	Continuous	88.3	1s
Ultra-pasteurization	Continuous	137.8	2s
Ultra High Temperature (UHT)	Aseptic	135-150	(4-15)s

Source: Food and Drug Administration,(2011).

2.2.4.1.4 Fermentation

After heat treatment ,the milk base is cooled to the incubation temperature used for growth of the starter culture an optimum temperature of the thermophilic lactic acid bacteria , i.e., *Streptococcus* subsp.*thermophilus* and *lactobacillus Delbrueckii* subsp.*bulgaricus* ,is around (40-45) ^{0}c .Bacterial fermentation converts lactose into lactic acid ,which reduces the pH of milk. During acidification of milk, the pH decrease from 6.7 to $\leq$4.6 **(Lee and Lucey, 2010).**

2.2.4.1.5 Cooling

When yogurt has reached the desired pH (4.5-4.6), it will then often blast chilled to refrigerated temperatures (<10^{0}C) in order to stop the fermentation process and there by stops further acid development **(Lee and Lucey, 2010).**

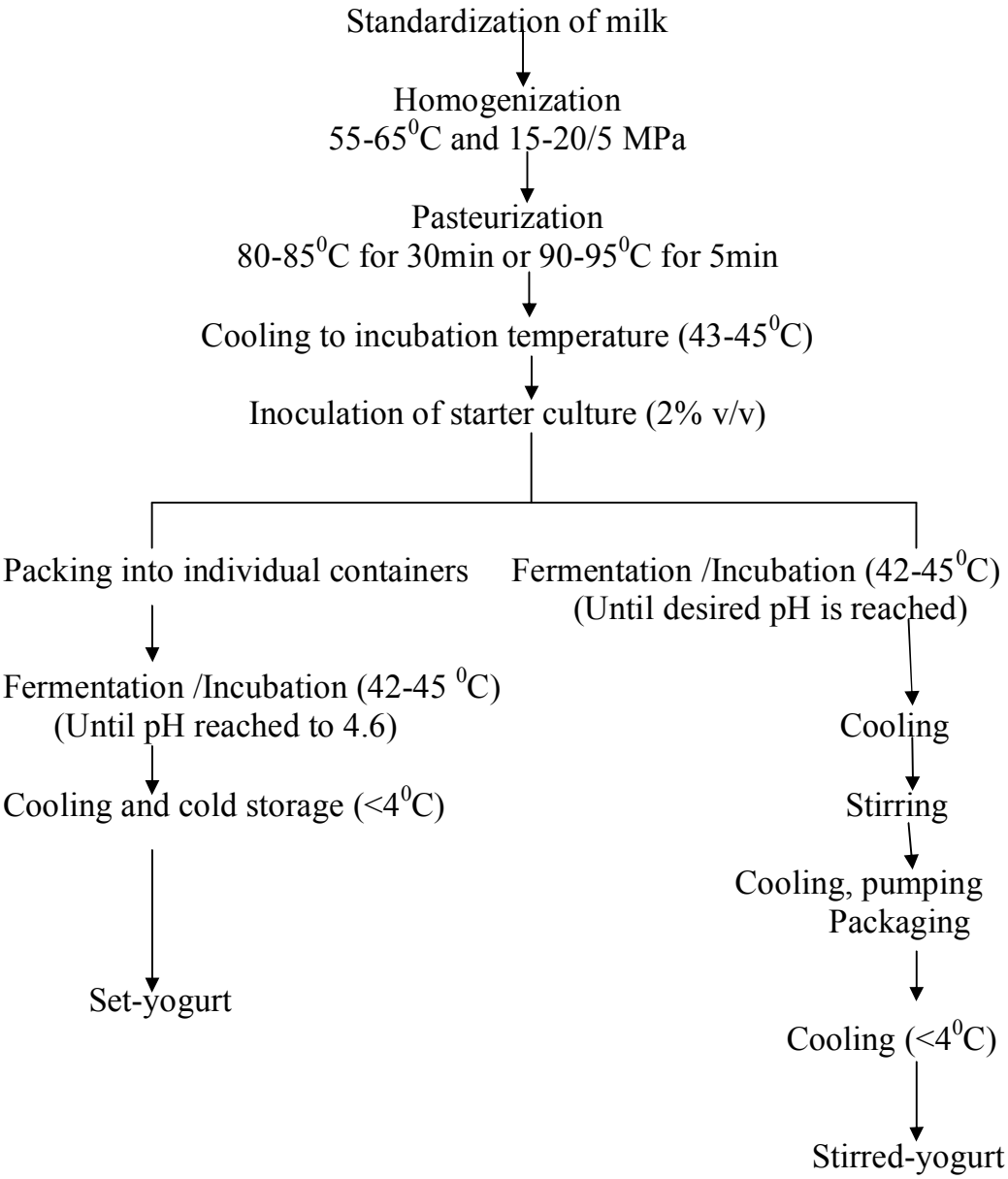

Figure 1: The production steps in manufacture of stirred and set yogurt are illustrated by (Lee and Lucey, 2010).

2.2.5 Shelf life of yogurt

The shelf life of fresh yogurt may be only a couple of weeks for unprotected operations and up to 6 weeks or more for well-operated – ultra clean operation and short, even if stored at low temperatures this may be due to the sanitary problems usually associated with its production and due to unhygienic handling of the product, which increases microbial contamination**.** The high microbial load of yogurt coupled with the packaging and storage conditions, result in the formation of off flavors and undesirable physicochemical changes that even- tually lead to rejection of product. One of the most accepted ways extend the shelf life of perishable food products are through the use of bio-preservatives **(Serra *et al.*, 2008)**.

2.2.6 Factor effecting the quality of yogurt

There are many factors affecting the quality of yogurt, but the most important factors are: types and composition of milk, heat treatment, starter culture, storage period of yogurt and the additives in yogurt **(Shori and Baba, 2012).**

2.2.7 Types of yogurt

a) Depending on method of production, the industries recognize two main type of yogurt that is set and stirred, this classification is based on the system of manufacturing and physical structure of the coagulum **(USDA, 2001)**

b) Based on flavor, there are different types of product:

-The first type namely natural or plain yogurt which is the traditional type with sharp acidic taste.

-The second type is yogurt with fruit made by addition of fruit and sweetening material to the natural yogurt.

-The third type is flavored yogurt which the fruit component is replaced with synthetic and coloring compounds

c) Based on post-incubation processing, yogurt can be differentiation into:

-Pasteurized yogurt, which is processed by convention method of manufacture, in addition to this procedure the yogurt undergoes heat treatment, to extend it s storage life.

- Frozen yogurt which is prepared in a conventional mode, but is then deep frozen yogurt to -20^0C.

- Concentrated and dried yogurt contains total solids of about 24% and 90_94% respectively.

d)Other type of yogurt in use are yogurt cheese and acidophilus yogurt **(Dairy UK,2009).**

2.2.7.1 Fruit yogurt

Fruit yogurt belongs to the milk mixer certification and contains additionally fruit or fruit preparation .The differences becomes depending upon fruit portion:

- Fruit yogurt or yogurt with fruit: at least 6% fresh fruit

-Yogurt with fruit preparation: at least3.5 fresh fruit

-Yogurt with fruit taste: less than 3.5fresh fruit **(Serra *et al.,* 2008)**.

Fruit yogurt is yogurt with added fruit. Fresh fruit must comprise at least six lemons; a minimal portion of two percent is prescribed. In the case of yogurt with fruit preparation of (fruit flavored yogurt) the fruit content is lower, higher level of fruit addition into yogurt would increase sensory quality of the fruit yogurt **(USDA, 2001).**

2.2.7.1.1 Preparation of fresh fruit

According to (Krasaekoopt and Bhatia,2012) fruit preparation as follows:

1-select ripened fruit

2-wash the fruit

3-Remove the skin and seed

4-Pulp the fruit

5-Heat the pulp for 15-20 minutes –at 70-80^{0}C (with usually stirring) or boil the fruit in boling water ,or exhibit to steam for 5 minutes

6-Cool at room temperature

7-Mix the pulp into stirred yogurt (e.g.) part pulp to between 3-5 parts yogurt .For set yogurt, the fruit is added in the bottom of cup and then the inoculated yogurt is poured on top and the yogurt is fermented in the cup for Swiss style yogurt, then blended with the fermented ,cooled yogurt prior to packaging

8-Store as for plain yogurt

2.2.8 The nutritional value of yogurt

Yogurt is a highly nutritious and easily digestible dairy product which is a rich source of more than ten essential nutrients in particular, certain minerals and vitamins. The nutritional composition of yogurt can be varied according to the strains of starter culture used in the fermentation, type of milk used (whole, semi or skimmed milk) species that milk is obtained (bovine,Goat, sheep). Type of milk solids, solid non-fat, sweeteners and fruits added before fermentation as well as the length of the fermentation process**(USDA, 2001).**

Table 2: Nutritional composition of different varieties of yogurt (Per 100 g):

Components	**Whole milk yogurt**	**Low fat yogurt**	**Non fat yogurt**
Energy(Kcal)	79	56	54
Protein(g)	5.7	4.8	5.4
Carbohydrate(g)	7.8	7.4	8.2
Fat(g)	3.0	1.0	0.2
Thiamin(mg)	0.06	0.12	0.04
Riboflavin(mg)	0.27	0.22	0.29
Niacin(mg)	0.2	0.1	0.1
Vitamin B6(mg)	0.10	0.01	0.07
VitaminB12(mg)	0.2	0.3	0.2
Foliate (µg)	18	18	8
Carotene (µg)	21	Trace	Trace
Vitamin D	0	0.1	Trace
Potassium(mg)	280	228	247
Calcium(mg)	200	162	160
Phosphorus(mg)	170	143	151

Source: The Dairy Council, (2013).

However, the general composition of yogurt is more or less similar to that of milk. Therefore, yogurt is a rich source of milk proteins, carbohydrate, minerals such as calcium and phosphorous, and vitamins

such as riboflavin (B2), thiamin (B1),cobalamin (B12), foliate (B9), niacin (B3) and vitamin A. Milk proteins available in yogurt is in high quality due to its high biological value and provide almost all essential amino acids necessary to maintain good health . In addition, milk proteins available in yogurt contain higher content of proline- and glycine-contain amino acids than that in whole milk while performing additional body functions such as enhancing calcium absorption and boosting the immune system .Lactose is the main carbohydrate found in yogurt as in other dairy products. Lactose content in raw milk is about 4.6%. However, the original lactose content in milk is lowered by 20-30% during the fermentation process as the lactose coverts into its simple forms of glucose and galactose due to the metabolic activity of lactic acid bacteria. Fat content of yogurt is highly dependable on the fat content of the original yogurt mixture. According to the USDA specifications for yogurt, low-fat yogurt and non-fat yogurt, fat content varies from 0.5-3.25% **(USDA, 2001)**.

The fat content of yogurt is highly subjective as some products; for instance Greek style yogurt contains a high fat content as high as10%. Unlike milk, processes that are employed in yogurt manufacturing such as homogenization and fermentation result in breakdown of some amount of fat into easily digestible and absorbable fatty acids **(Guslandi *et al.*, 2000)**.

Vitamins and minerals found in milk and dairy products are in bio-available from where they are available for absorption and use by body. Yogurt as of other dairy products is an exceptional source of several B vitamins in particular, riboflavin and thiamin. It is reported that a 150g serving of whole milk plain yogurt and low-fat plain yogurt will provide

31% and 30% of an adult's daily riboflavin requirement respectively whereas the same amount of serving of each type of yogurts will provide 23% and 45% of an adult's daily thiamin requirement .However, vitamin B12 and B6 are found in significantly lower concentrations than that in milk as *Streptococcus thermophilus* uses these B vitamins for its metabolism. Folic acid /foliate content of yogurt can be varied depending on the composition of lactic acid bacteria used as some of the LAB species such as *S. thermophilus* and Bifidobacteria synthesize certain vitamins including foliate by their own **(Guslandi *et al.*, 2000).**

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials

- Fresh cow milk with pH 6.74, fat3.3, acidity0.135, solid nonfat 8.6, total solids 12.
- Skim milk powder with fat 0.8, SNF95.2, TS 96, moisture 4.
- PREMIGUM XLY-12007-DD stabilizer (E-440 standardized with dextrose) (Spain) with (moisture 11, PH (1.5% sol. In milk) 6.5).
- Yogurt starter culture (*Streptococcus thermophillus* and *Lactobacillus delbrueckii subsp.bulgaricus*) Chrestan hansan(france).
- Stirred yogurt obtained from DAL dairy factory containing 14.60%total solid,3.11%fat.And manufactured from fresh milk, skim powder, stabilizer and yogurt culture.
- Guddaim sample obtained from local market in Omdurman.

3.2 Methods

3.2.1 Preparation of fruit juice

The juice was prepared from Guddaim fruits as follows: the whole ripe fruits were cleaned, washed with tap water and soaked in water (4x fruit volume) for 3 hour, then blended into juice using a blender followed by filtering and then they were heated to 95^0C for 10 min. The fruit juice were cooled to 45^0C and cold stored until used. Three different concentrations were used [10%v/v (T1), 15%v/v (T2) and 20%v/v (T3)].

3.2.2 Manufacture of yogurt

Stirred yoghurt was manufactured as follows: milk was analyzed to ensure it does not contain any foreign material, and premigum xly-12007-DD stabilizer was added (0.2% w/v). The mixture was pasteurized at 90^0C for 15 min followed by cooling rapidly to 45^0C, and then inoculated with 3% (v/v) yoghurt culture of *Lactobacillus delbrueckii subsp bulgaricus* and *Streptococcus thermophilus* (1:1 ratio). After incubation (45^0C for 3 hr), the curd was stirred to break, and the fruit juice was added to give three treatments (T1, T2, T3), in addition to the control(C). Yogurt was stored at 4^0C for one day, and chemical, physicochemical, microbiological and sensory evaluation carried out.

3.2.3 Chemical determination of Guddaim fruits

3.2.3.1 Moisture content

Moisture was removed from Guddaim sample by heating at 98-100 ^{0}C in force-draught oven for 3 hours **(AOAC, 2000)**.Five grams of the samples in a reweighed flat bottom dish were heated on a steam bath for 10-15 minutes before transfer to the oven.

The dish was cooled in desiccators and weighed .The weight of the residue was obtained and expressed as percentage total solids and the weight lost represented the moisture content.

$$\text{Moisture content (\%)} = \frac{W1-W2}{\text{Wt of sample}} \times 100$$

3.2.3.2 Protein content

Protein content of Guddaim samples determined by Kjeldahl's method (991.20)of (**AOAC, 2000)**.One gram of Guddaim sample was

digested in Kjeldahl digestion flask with concentrated sulfuric acid and digestion tablets until clear solution was obtained. The ammonium trapped in sulfuric acid was released by adding 40% sodium hydroxide and distilled into 50 ml 4%boric acid solution then it was titrated against hydrochloric acid 0.5N to determine the amount of nitrogen .protein content in Guddaim was determined by multiplying N% with a factor 6.38.

$$\text{Nitrogen (\%)} = \frac{\text{Vol. (sample – blank) HCL} \times \text{normality of HCL} \times 0.014}{\text{Weight of sample}} \times 100$$

Protein (%) = N (%)× 6.38

3.2.3.3 Fat content

The crude fat content in the row materials were determined according to(**AOAC, 2000)**

The method determines the substances which are soluble in petroleum ether (B.p, 40-60^0 C) and extractable under the specific conditions of Soxhlet extraction method. The dried (crude fat) is then weighed and reported as percentage of the total dry matter. Dried sample of 2 g ±mg was weighed into an extraction with extraction thimble (30×١٠٠ mm) and covered with cotton the previously extracted with petroleum ether. Then the sample and a pre-dried and weighed flask containing about 75ml petroleum ether (No.28111,DOO,England) were attached to soxhlet extraction unit (Electro Thermal, England)and the temperature was adjusted to(60-70) ^{0}C for 16 hours. At the end of the distillation period, the flask was disconnected from.

3.2.3.4 Fiber content

The crude fiber content in the different samples was estimated according to the method of the **(AOAC, 2000)**.

The crude fiber is the organic residues which remained after the food sample is digested in a chemical solution. The weighed of the residue after digestion is then corrected for ash content and is considered as a crude fiber. About 1 g ±1mg from the defatted sample was weighed in conical flask follow by addition of 200 ml of [0.255N] H_2SO_4. Then the flask was connected to a digestion unit (Electro mantle ME, Britain) and the sample was boiled exactly for 30 minutes.

At the end of the digestion period, the flask was removed and the digest was filtered, the precipitate was repeatedly washed with distilled boiling water, following by second digestion in 200ml of sodium hydroxide (0.313N) under the reflux condenser for 30 min.

After that, the precipitate was filtrated through a Gooch crucible and washed with hot distilled water followed by 15 ml of ethyl alcohol .finally, the crucible was dried at 105^0C to constant weighed, cooled (in a desiccator), weighed and ashed in a muffle furnace (No.20-30178,carbolate ,England**)** at 550-600 ^{0}C until a constant weighed was obtained and difference in weighed was considered as crude fiber.

$$\text{Crud fiber \%} = \frac{[\text{Dry residue crucible (g)}]-[\text{ignited residue + crucible(g)}]}{\text{sample wt(g)} \times [\,١٠٠\%-\text{sample moisture (\%)}]} \times ١٠٠$$

3.2.3.5 Ash content

The sample (2g) was weighed into porcelain crucible .This was transferred into the muffle furnace set at 550^0c and left for about 4 hours. About this time it had turned to white ash .The crucible and its content were cooled to about 100^0c in air, then room temperature in desiccators and weighed **(AOAC, 2000).**

The percentage ash was calculated from the formula below:

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Original weight of sample}} \times 100$$

3.2.3.6 Available carbohydrates content

The available carbohydrates content of the different samples was calculated by subtracting the total sum of protein, ash, fat, and moisture and crud fibers percentages from 100% as it was describe by **(AOAC, 2000).**

Carbohydrates content=100-(moisture % +crude protein% +crude fat% +ash % + crude fiber %).

3.2.3.7 Minerals content

Dry ashing can be used for sample preparation in the determination of calcium and iron in plant tissue. It may also be applicable to other elements. If the concentration of the element of interest is too low, the metal can be complexed and extraction into an organic solvent such as MIBK to increase its concentration (10).

One gram of sample was weighed into a porcelain crucible. Then placed in a cool muffle furnace and ashed at 500 ^{0}C overnight. The ash

was cooled and dissolved in 5-ml of 20%HCL.Then warmed the solution, if necessary to dissolve the residue. The solution was filtered through an acid-washed filter paper into a 50-ml volumetric flack. The solution was diluted to volume with de ionized water and mixed well. **(AAS, 1994).**

3.2.4 Chemical determination of Guddaim yogurt

3.2.4.1 Determination of fat, protein and total solids

The fat, protein and total solids determined by using calibrated food scan S/N 3187671061, FOSS analytical.

3.2.4.2 Determination of ash

The sample (2g) was weighed into porcelain crucible .This was transferred into the muffle furnace at 550^0C and left for about 4 hours. About this time it had turned to white ash .The crucible and its content were cooled to about 100^0c in air, then room temperature in desiccators and weighed **(AOAC, 2000).**

The percentage ash was calculated from the formula below:

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Original weight of sample}} \times 100$$

3.2.5 Physicochemical determination

3.2.5.1 Determination of pH

The pH of samples was determined by electronic pH meter (JENWAY 3510 pH meter, designed and manufactured in the UK by Bibby Scientific Stone LTd, model 33510, serial no.51030).

3.2.5.2. Determination of Titratable Acidity of Guddaim yogurt

The Guddaim yogurt was mixed well and accurately transferred 10ml of Guddaim yogurt to beaker by graduated pipette. Then 3 drops of phenolphthalein indicator solution was added by plastic dropper bottle and then titrated with 0.1N sodium hydroxide until the first pink end point was reached by automatic burette and recorded the volume of sodium hydroxide used **(AOAC,2000)**.

Total acidity %(g/100ml lactic acid)=Vol NaoH (ml)x0.09

$$\text{Acidity\%} = \frac{\text{Vol NaoH (ml) Normality of NaoHx0.09}}{\text{Ml of sample}} \times 100$$

3.2.5.3 Acidity of Guddaim juice

The juice mixed well and accurately transferred 5ml of juice to beaker by graduated pipette. Then 3 drops of phenolphthalein indicator solution was added by plastic dropper bottle and then titrated with 0.1N sodium hydroxide until the first pink end point was reached by automatic burette and recorded the volume of sodium hydroxide used **(AOAC,2000)**.

$$\text{Total acidity/100 ml} = \frac{T \times N \times A \times 100}{V \times 1000}$$

Total acidity/100 ml = Tx0.128

Were T=ml NoaH used .N=Normality of NaoH used (0.1) A=Acid factor

V=Volume of the sample

3.2.5.4 Determination of brix

Brix determined by using A Kruss Optronic digital hand refracto meter Dr 301-95.

3.2.5.5 Determination of viscosity of Guddaim yogurt

Viscosity was determined by Anton paar viscometer, made in Austria, Reolab QC P/N 18318, S/N 81811601, DC.15V, 1.5 A.

3.2.6 Microbiological analysis

3.2.6.1 Preparation of media

All media were obtained in a dehydrated form stored in hygroscopic environment in a cool dry place, away from light and prepared according to the manufactures instructions.

3.2.6.2 Types of culture media used for micro biological examination of stirred yogurt:

3.2.6.2.1 Violet red bile agar (Merck)

This medium was used to determine the total coliform counts**(Harrigan and McCance,1976)**.It was obtained in dehydrated form each dehydrated liter of the medium composed of lactose (10.0grams), neutral red(0.03grams),sodium chloride(13.0grams),crystal violet(0.002grams) and agar agar(13.0grams).

According to the manufacturer`s instructions 39.5 grams were suspended in 1000 ml distilled water. It was boiled to dissolve completely and sterilized by water bath at 100^0C for 30 minutes, cooled to 45±and immediately poured into sterile petri dishes containing the dilution. Yeast extract glucose, chloramphenicol agar (YGC.agar,Merck).This medium was used to determined the total yeast and mould counts (**ISO6611, 2004)**.It was obtained in a dehydrate form .Each rehydrated liter of the medium composed of yeast extract (5grams), glucose (20

grams),chlormphenicol(0.1) and agar (14.9 grams).According to manufacturer`s, 20 grams were suspended in 1000 ml distilled water ,boiled to dissolved completely and sterilized by autoclaving at 15 bar pressure 121^0C for 15minutes ,cooled to 45± 2^0C and immediately poured into sterile Petri dishes containing the dilution (**ISO6611, 2004)**.

3.2.6.2.2 Standard plate count agar (Merck)

This medium was used to determine the total bacterial count **(Houghtby *et al*., 1992)**. It was obtained in dehydrated form (Biomarker,298). Each rehydrated liter of the medium composed of casein enzymichydrolysate (5.0grams), yeasts extract (2.5grams), dextrose (1gram)and agar(15 grams).According to manufactures instruction ,23.5grams were suspended in 1000ml distilled water ,it was boiled to dissolve completely and sterilized by autoclaving at 121^0C for 15 minutes.

3.2.6.3. Preparation for plating

3.2.6.3.1 Sterilization of equipments

Glass wares such as test tube, pipettes, Petri-dishes, flasks and bottles were sterilized in a hot oven at 180^0C for one hour, whereas ringer solution and tips were sterilized by autoclaving for 15 minutes at 121^0C (**Richardson ,1985)**.

3.2.6.3.2 Plating method

One ml of the yogurt sample was transferred aseptically by sterile pipette to 9ml sterile ringer`s solutions .This procedure was repeated to make tenfold dilutions from 10^{-1}-10^{-3} According to **(Richardson ,1985)**.

Culturing method from each dilution, 1ml was transferred to duplicate Petri-dishes and the culture medium was poured aseptically into each Petri-dish using pour plate technique, mixed gently left to solidify and incubated in an inverted position. The cultured Petri-dished for the coliform count were incubated at 37^0C for 24hours, 23^0C for 48hour for the total bacterial count and 28^0C for 5days was estimated for the yeasts and moulds count. The typical colonies in each Petri-dish were counted using a colony counter **(Houghtby *et al.*, 1992)**.

3.2.7 Sensory evaluation method

Sensory evaluation test determined according to5point hedonic scale designed by (**Ihekoronye and Ngoddy, 1985)**. A hedonic rating is a technique to measure the degree of liking for a product by untrained assessors. A 5-point hedonic scale designed was employed to elucidate panelist`s acceptance of appearance, flavor, texture, and overall acceptability of the control and the three experiments. Every panelist received the four types of formulation to be judged side-by-side and water for rinsing. Before tasting the products, panelists ,were asked to evaluate the sample`s appearance using a 5-point hedonic scale ranging from "5-excellent, 4-very good, Good, 2-acceptable, 1-poor"After judging appearance, the panelists were then allowed to taste the samples and evaluate their flavor, texture, and overall acceptability using a 5-point hedonic scale, once again ranging from "5-excellent, 4-very good, Good, 2-acceptable, 1-poor".

Table 3: Panel test form

Directions: rate each of the following: color, flavor, consistency, taste and overall acceptability for the following samples of yogurt.

Sample code / Attributes	C	T_1	T_2	T_3
Color				
Flavor				
Consistency				
Taste				
After taste				
Overall acceptability				

Excellent≡5, Very good≡4, Good≡3 ,Acceptable≡2, Poor≡1 (**Ihekoronye and Ngoddy, 1985).**
T_1≡ yogurt treated with Guddaim concentration 10%.
T_2≡ yogurt treated with Guddaim concentration 15%.
T_3≡ yogurt treated with Guddaim concentration 20%.
C ≡ control

3.2.8 Statistical analyses

The results were analyzed using Statistical Analysis Systems (SAS).Results on physicochemical, chemical, microbiological, minerals and sensory profiles were analyzed by one-way analysis of variance (ANOVA).Mean separation was done by Duncan multiple range tests at $P \leq 0.05$.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Proximate composition of Guddaim

Table (4) presents the proximate composition of Guddaim whole fruit (*Grewia tenax*) was found to be moisture is 16.22 % with a highest level of available carbohydrates which represent about 53.46%, following by total sugars 34.18, crude protein 11.43 %, crude fiber 10.39 % , fat 4.37% and ash 4.12 %.

Among the available carbohydrates, the reducing and non-reducing sugar was found to constitute about 17.56 and 16.82 respectively.

However except for ash the results obtained in this study are disagreement with those reported previously by EL-Amin (1995) and AL-Rikain (2004), and this results is similar to results which found by Mohammed *et al.* (2011).

4.2 Proximate composition (%) and energy content of yogurt treated with Guddaim.

Table (5) and fig(2-8) show the proximate composition (%) and energy content of yogurt treated with Guddaim.

From the results it is obvious that the addition of Guddaim did not increase the chemical properties of yoghurt in comparison to control , except moisture which increased. The lowest fat content was in T_2 and lowest protein and CHO contents were in T_3. These findings are in disagreement with Andronoiu *et al,*(2011) who reported an increase in the

chemical properties of yoghurt with the addition of walnuts and strawberries jam.

The decrease in fat content was in agreement with the results of Tarakci (2010) who found a decreasing trend of fat as the concentration of the added marmalade increased from 0% to 20%, and Kucukoner and Tarakci (2003), Ayar *etal.* (2006) and Cinbas and Yazici (2008) who found that the fat content of yoghurt decreased with the addition of different fruit juice.

Although Guddaim fruit has a protein content of 6.3% -8.7% (Gebauer *et al*., 2007; Mohammed Elhassan and Yagi, 2010), the protein content of yoghurt decreased with the addition of Guddaim to yoghurt but not greatly. The findings of this study are in one line with those of Kucukoner and Tarakci (2003) and Ginbas and Yazici (2008).

All treatments had lower ash content compared to control. This results are in one line with Iwalokun and Shittu (2007) and Andronoiu *et al.* (2011), and disagree with Kucukoner and Tarakci (2003), Cinbas and Yazici (2008) and Tarakci (2010).

The energy of control is highest than (T_1. T_2 .T_3) .This decrease may be due to added Guddaim juice.

4.3 Physicochemical properties of yogurt treated with Guddaim

Table (6) and fig (9-13) show the physicochemical properties of yogurt treated with Guddaim, when we found the addition of Guddaim to yogurt not increase in any parameter of analysis except in titratable acidity which increased with addition of Guddaim.

In pH samples show not significant difference between T_2 and T_3, but there significant difference between control, T_1, T_2 and T_3, may be due to addition of Guddaim juice (D) which has lower pH than control.

Also there significant difference between control and all treatments in viscosity which decreased with addition of Guddaim from control to T_3, likewise in brix. Where all treatments have lower content in viscosity and brix compared with control.

The titratable acidity decreased in T_1 and increased in T_2 and T_3 than control. And there not significant difference between T_2 and T_3, but there significant difference between control and T_1.

4.4 Microbiological load of yogurt treated with Guddaim:

Table (7) and fig(14-15) show total viable bacteria count (TVBC) ranged from log 3.35 cfu /g in T_3 to log 4.00 cfu/gm in control . This results is agreement with tarakcr and kucukoner(2003) reported lower initial bacterial count in fruit –flavored yogurt and disagreement with(vahedi *et al ,.(2008)* and mbaeyi and anayanwu(2010).

Coliform bacteria count is nill. This result is agreement with (okoye and animal, 2009; mpaeyi and anyanwu, 2010).

Yeasts and moulds count ranged from log 5.00 cfu/gm in control to log 10 cfu /gm in all treatment(T_1, T_2, T_3).This results disagreement with (okoye and animal,2009) which reported no fungal growth in yogurt stabilized with sweet potato and this increase of yeasts and moulds may due to environmental conditions during preparation.

Table 4: Proximate composition of Guddaim

Parameter	Mean±SD
Moisture content	16.22±1.24
Crude protein	11.43±0.23
Fat content	4.37±0.61
Available carbohydrates	53.46±0.56
Crude fiber	10.39±0.06
Ash content	4.12±0.60
Total sugars	34.18±1.07
Reducing sugars	17.56±0.26
Non-reducing sugars	16.82±0.66

Values are mean±SD.
SD ≡Standard deviation.

Table 5: Proximate composition (%) and energy content of yogurt treated with Guddaim.

Parameter	Control	T_1	T_2	T_3	$Lsd_{0.05}$	SE±
Moisture content	79.41±01[b]	80.01±0.12[b]	80.58±0.06[a]	80.57±0.16[a]	0.2912[*]	0.07416
Crude protein	3.415±0.04[a]	3.335±0.02[a]	3.335±0.04[a]	3.025±0.05[b]	0.0878[*]	0.02236
Fat content	2.855±0.02[a]	2.630±0.00[a]	2.470±0.01[a]	2.820±0.69[a]	0.9618[NS]	0.2449
Ash content	0.800±0.03[a]	0.720±0.03[a]	0.629±0.02[b]	0.416±0.03[c]	0.0878[*]	0.02236
Available CHO	27.66±0.01[a]	26.28±0.74[b]	25.86±0.07[b]	25.70±0.52[b]	1.26[*]	0.3209
Energy (kcal/g)	150.00±0.39[a]	142.11±3.05[a]	139.00±0.28[a]	140.24±8.11[a]		

Values are mean±SD.

Mean value(s) bearing different superscript(s) in a row are significantly different ($P \leq 0.05$).

$Lsd_{0.05}$ ≡ level of standard deviation.

SE± ≡ Significant error.

NS≡ Not Significant

T_1≡ yogurt treated with Guddaim concentration 10%.

T_2≡yogurt treated with Guddaim concentration 15%.

T_3≡ yogurt treated with Guddaim concentration 20%.

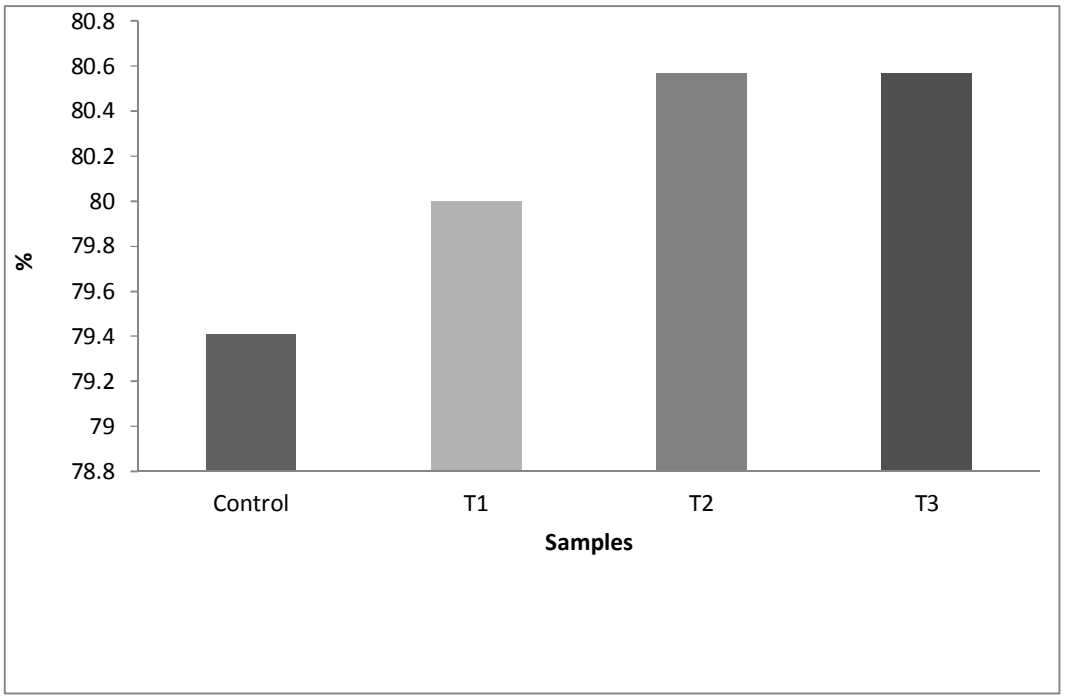

Figure 2: Moisture content of yoghurt supported with Guddaim

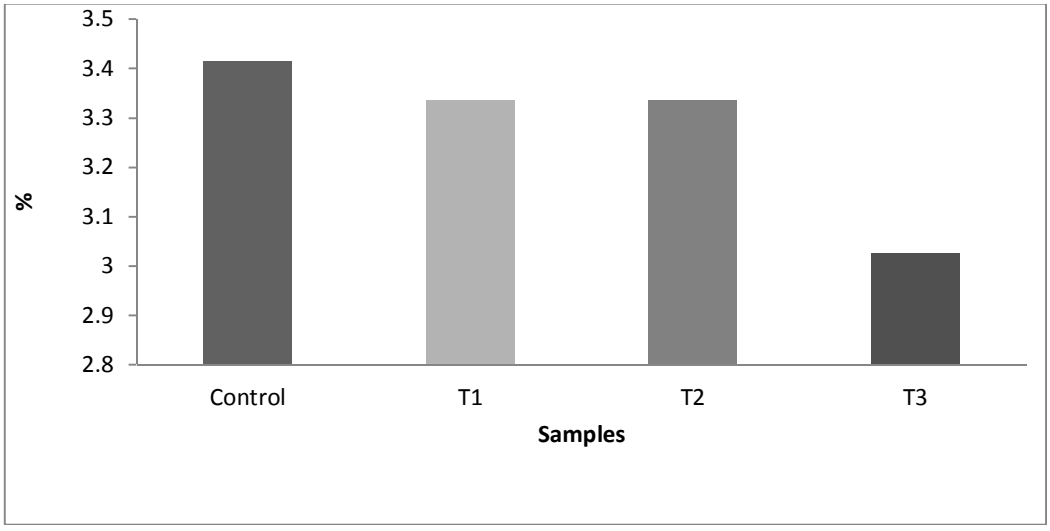

Figure 3: Crude protein of yoghurt supported with Guddaim

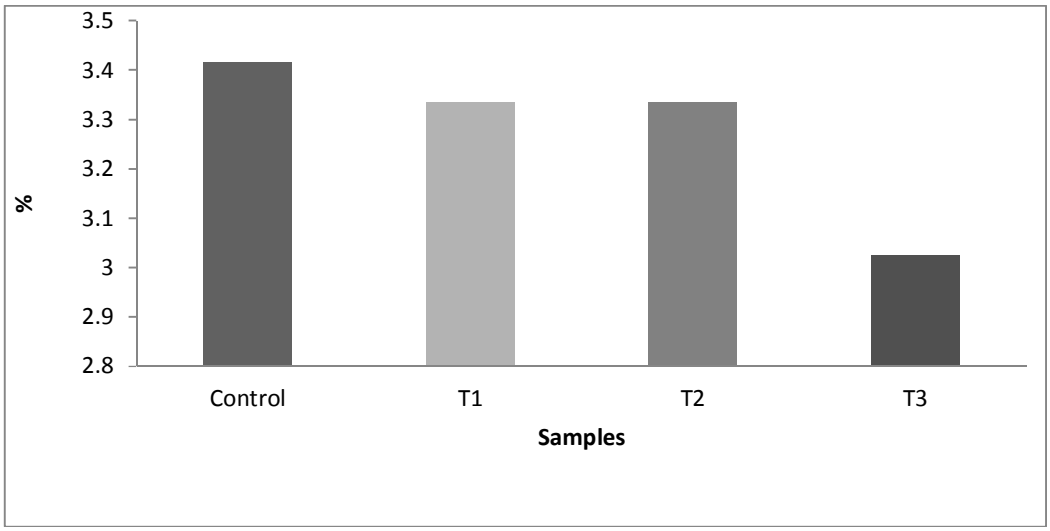

Figure 4: Crude protein of yoghurt supported with Guddaim

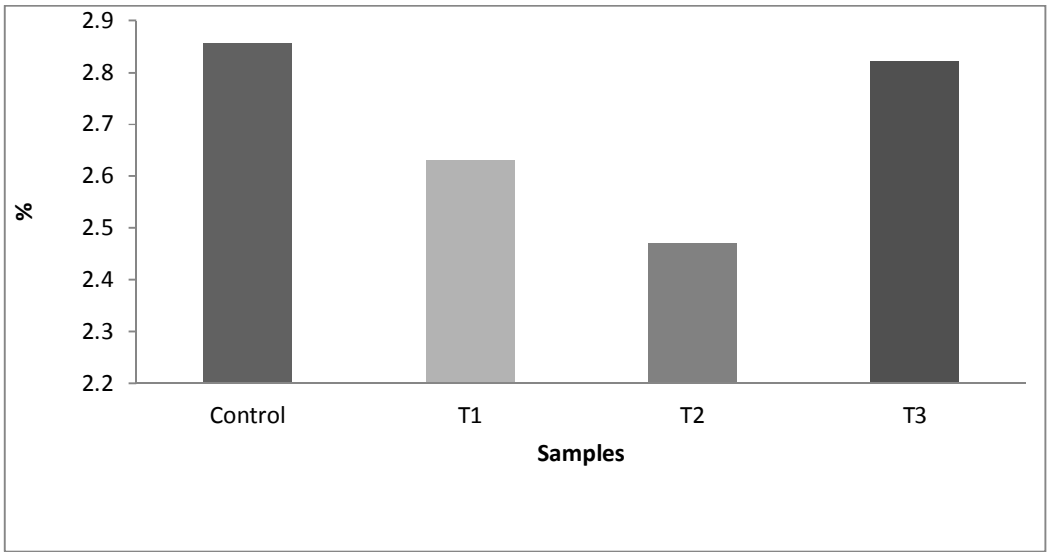

Figure 5: Fat content of yoghurt supported with Guddaim

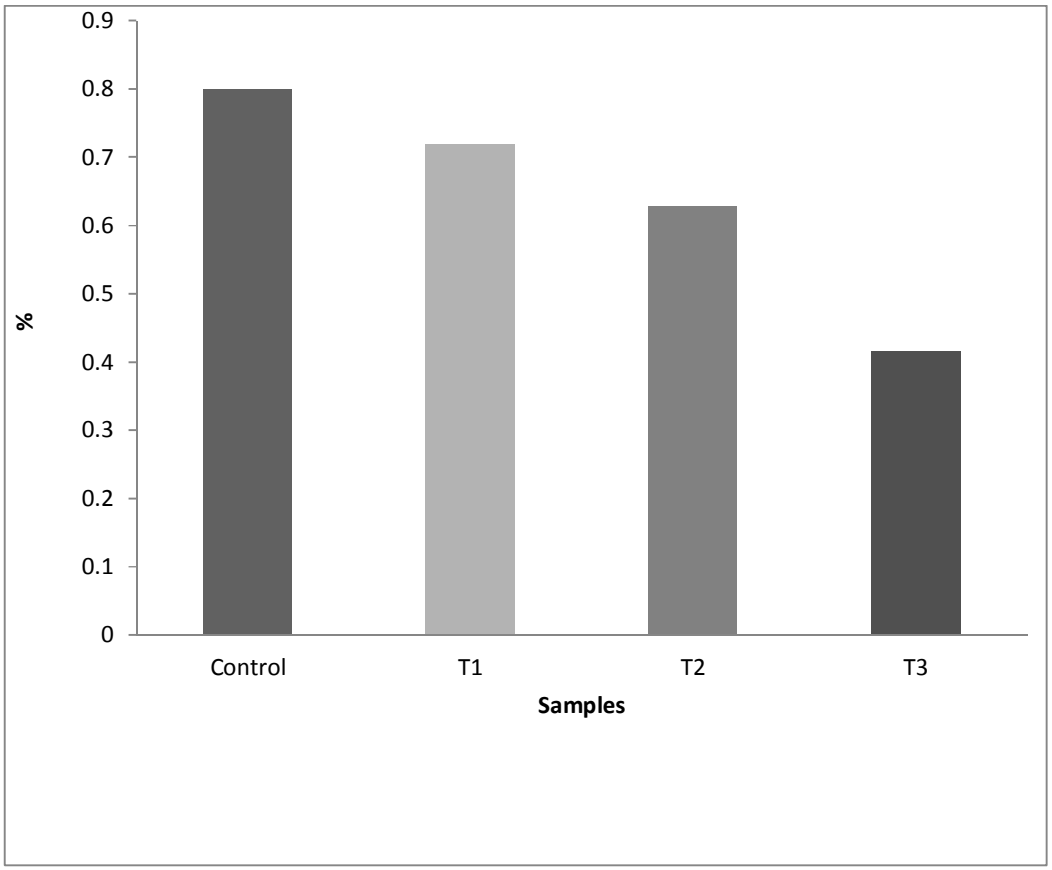

Figure 6: Ash content of yoghurt supported with Guddaim

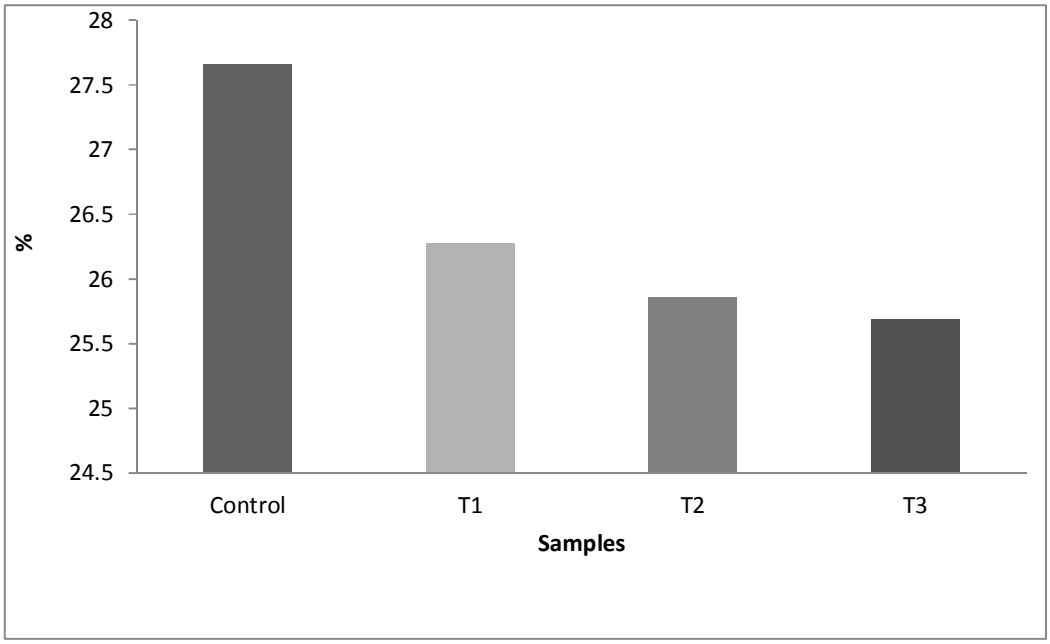

Figure 7: Carbohydrates of yoghurt supported with Guddaim

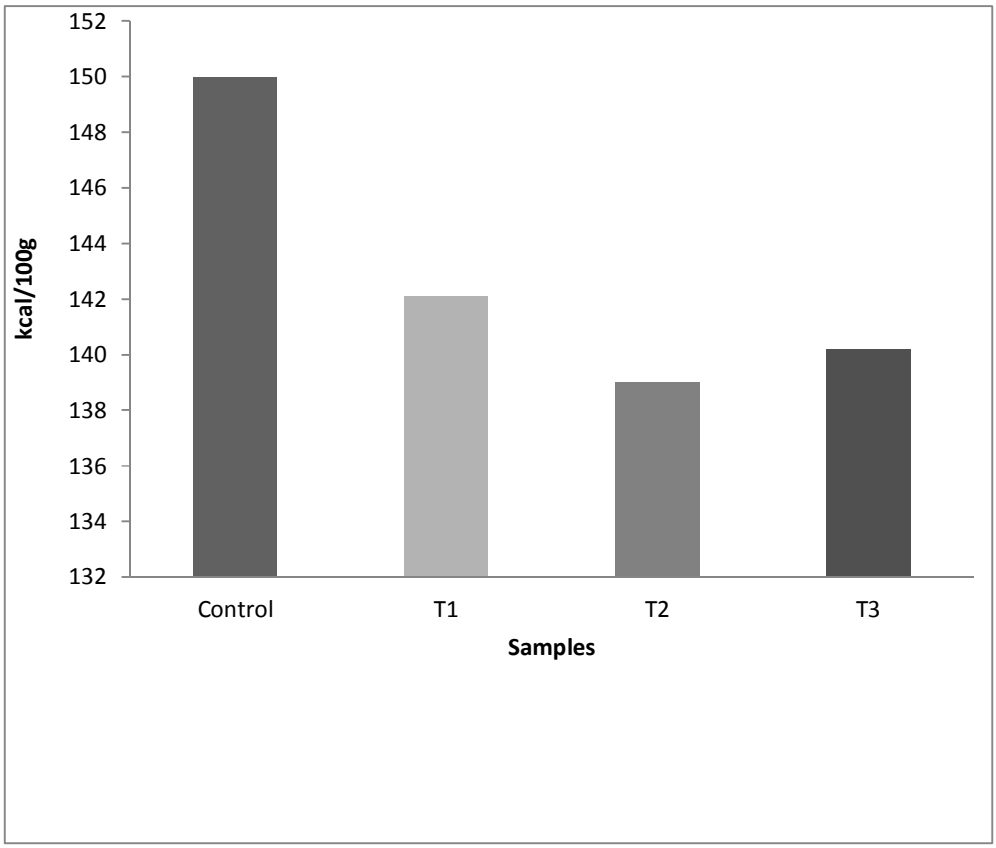

Figure 8:energy value of yoghurt supported with Guddaim

Table 6: Physicochemical properties of yogurt treated with Guddaim

Parameter	Control	T_1	T_2	T_3	D	$Lsd_{0.05}$	SE±
pH-value	4.46 ± 0.01^{a}	4.44 ± 0.01^{b}	4.40 ± 0.01^{c}	4.40 ± 0.00^{c}	3.85 ± 0.02^{d}	0.0008129^{*}	0.0002236
Titratable acidity (% citric acid)	0.890 ± 0.00^{b}	0.865 ± 0.04^{b}	0.900 ± 0.01^{a}	0.935 ± 0.04^{a}	-	0.0878^{NS}	0.02236
Viscosity (c.p)	58.79 ± 1.64^{a}	51.45 ± 1.94^{b}	36.43 ± 2.02^{c}	30.55 ± 1.93^{d}	-	5.237^{*}	1.334
Total solids (%)	20.57 ± 0.02^{a}	20.00 ± 0.12^{b}	19.43 ± 0.06^{c}	19.43 ± 0.16^{c}	7.50 ± 0.14^{d}	0.2931^{*}	0.08062
Brix°	13.80 ± 0.00^{a}	13.70 ± 0.00^{b}	13.65 ± 0.07^{bc}	13.60 ± 0.00^{c}	-	0.0878^{*}	0.02236

Values are mean±SD.

Mean value(s) bearing different superscript(s) in a row are significantly different ($P\leq0.05$).

$T_{1\equiv}$ yogurt treated with Guddaim concentration 10%.

$T_{2\equiv}$ yogurt treated with Guddaim concentration 15%.

$T_{3\equiv}$ yogurt treated with Guddaim concentration 20%.

D≡ Guddaim juice

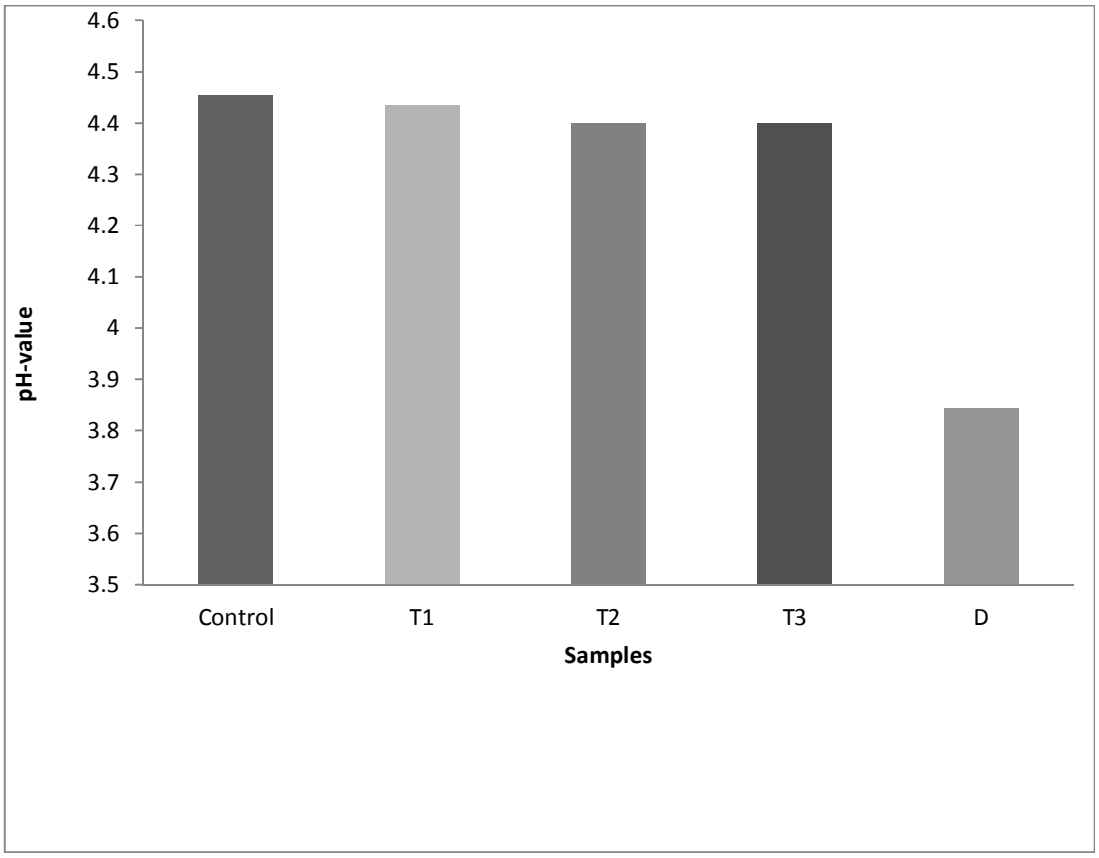

Figure 9: pH-value of yoghurt supported with Guddaim

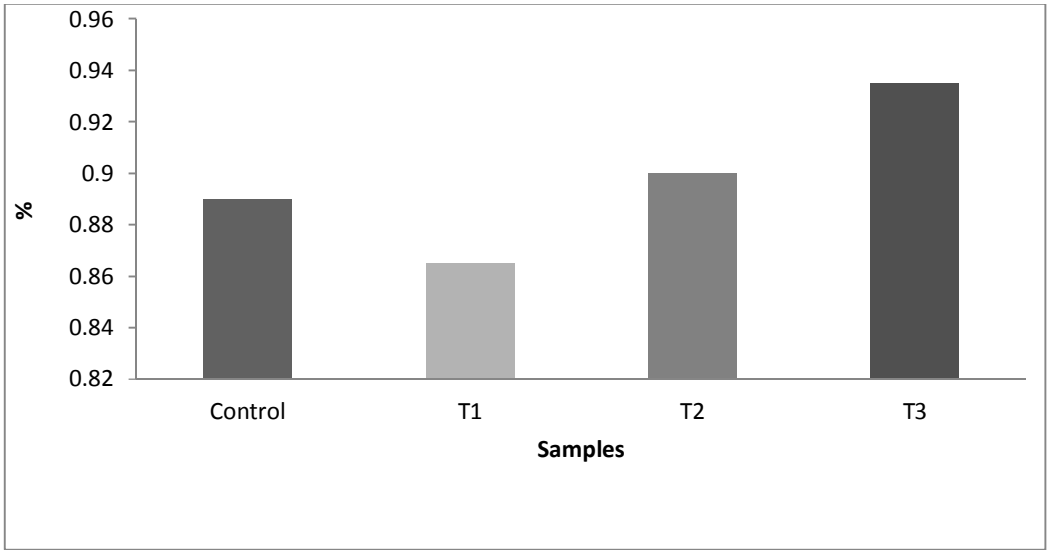

Figure 10: Titratable acidity of yoghurt supported with Guddaim

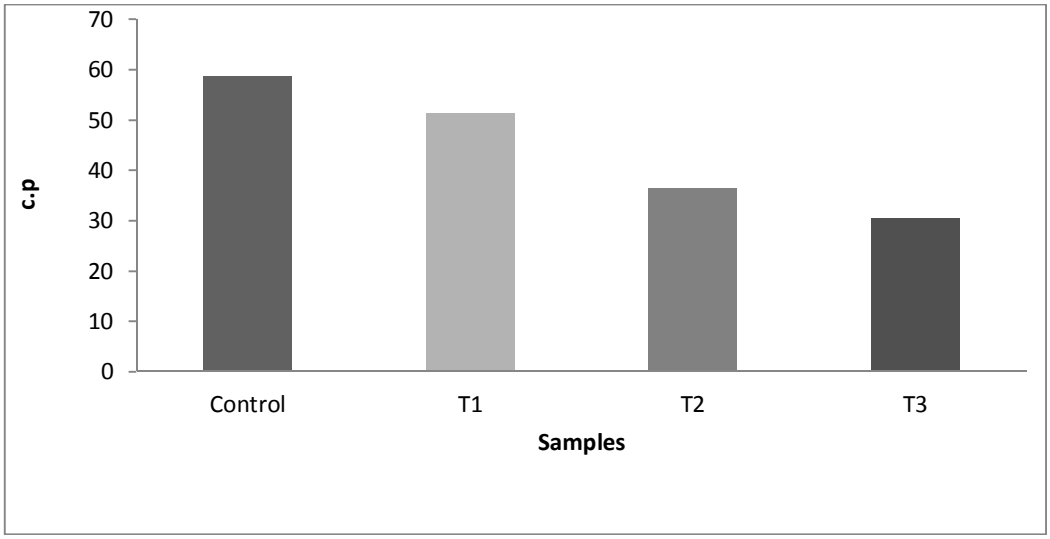

Figure 11: Viscosity of yoghurt supported with Goddaim

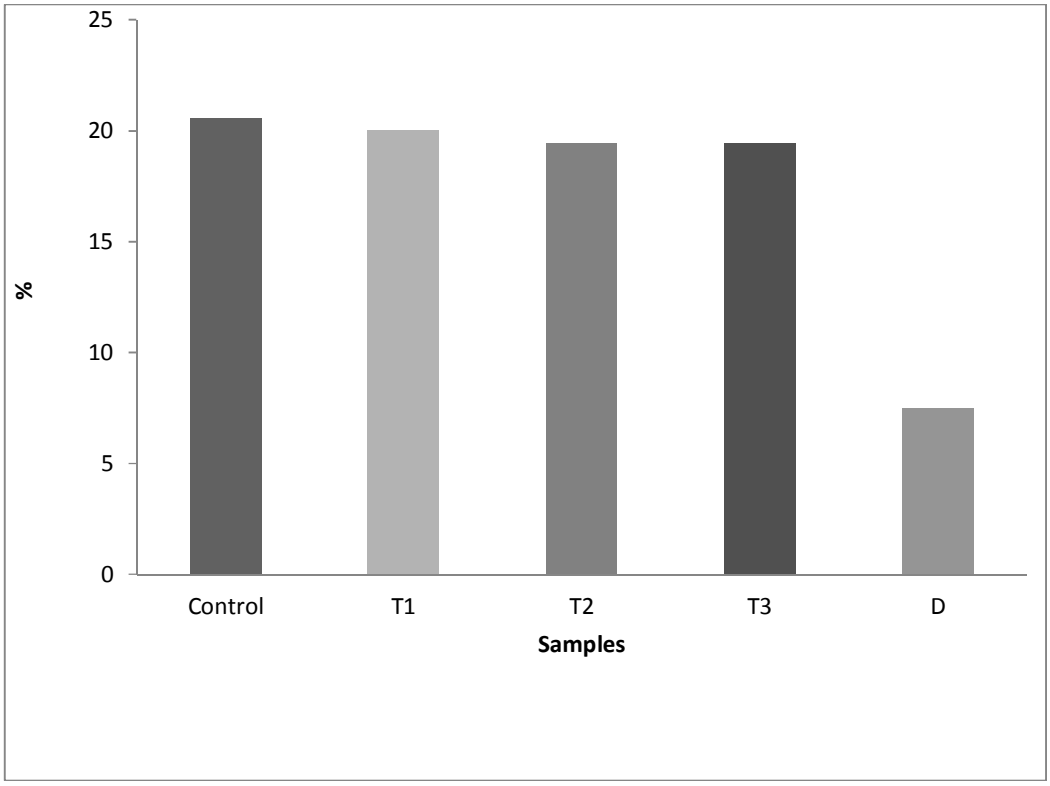

Figure 12: total solids of yoghurt supported with Guddaim

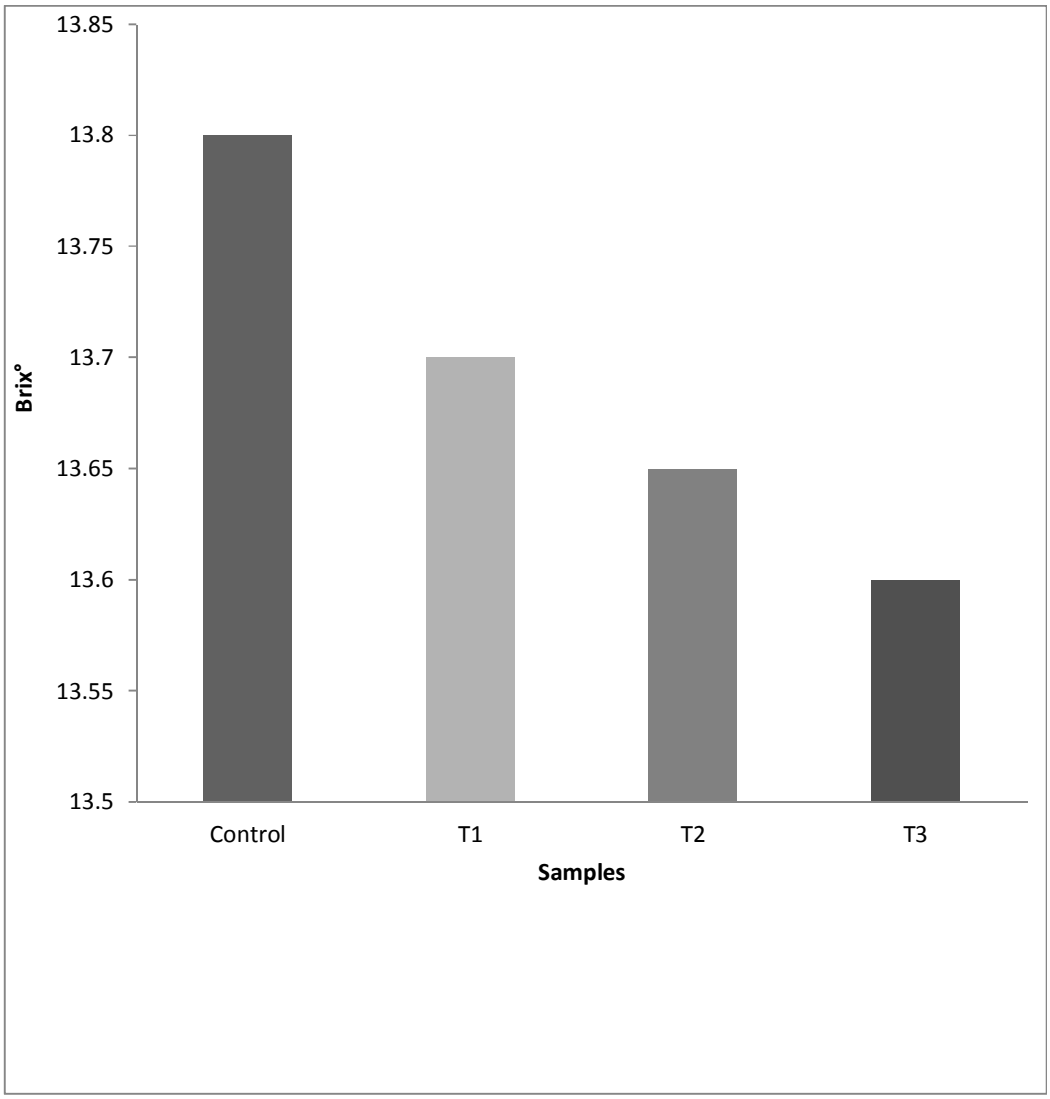

Figure 13: brix° of yoghurt supported with Guddaim

4.5 Minerals content (mg/100g) of yogurt treated with Guddaim

Table (8) shows the minerals calcium and iron content of yogurt treated with Guddaim as mg per 100g. From the results was found that calcium content increased in control from 4.39 to 19.68 in T_1 ,21.13 in T_2 ,20.47 T_3 .There was significant difference in all results.

The calcium content increased in all treatments (T_1 T_2 T_3).The iron content increased in T_1 T_2 T_3 due to concentration of Guddaim added. There was no-significant difference between T_2 and T_3 ,but there significant difference was found between them and control.

4.6 Sensory evaluation of yogurt treated with Guddaim

Table(9) and fig16 show Sensory evaluation of yogurt treated with Guddaim.

presents the results of sensory evaluation of yogurt made with different concentrations of Guddaim by trained and untrained panelists on a scale of 5.There was no significant difference ($p<0.05$) between the control ,T_2 and T_3 in color and overall acceptable compared with T_1 which obtained lower value than other.

There no significant difference between control, T1 and T_2 in flavor and after taste compared with T_3 which obtained highest value may be due to T_3 has a high concentration of Guddaim juice.

As well sensory panelists did not show any significant difference between control and T_3 in taste and likewise between T_1 and T_2 but the control obtained highest value than T_3 and T_3 than others.

There was significant difference between control and other treatments (T1, T2, T3) in consistency. From this sensory evaluation it was found the T_3 obtained highest value in over all acceptability than others.

Table 7: Microbiological load of yogurt treated with Guddaim

Samples	Total viable count of bacteria (log_{10} cfu/g)	Coliforms (MNP/g)	Yeasts and moulds (log_{10} cfu/g)
Control	4.00 ± 0.28^{a}	Nill	5.00 ± 7.07^{a}
T_1	3.50 ± 0.28^{ab}	Nill	10.00 ± 0.00^{a}
T_2	3.40 ± 0.00^{ab}	Nill	10.00 ± 0.00^{a}
T_3	3.35 ± 0.21^{b}	Nill	10.00 ± 0.00^{a}
$Lsd_{0.05}$	0.627^{*}	-	9.816^{NS}
SE±	0.1597	-	2.50

Values are mean±SD.

Mean value(s) bearing different superscript(s) in a column are significantly different ($P\leq0.05$).

$T_{1\equiv}$ yogurt treated with Guddaim concentration 10%.

$T_{2\equiv}$ yogurt treated with Guddaim concentration 15%.

$T_{3\equiv}$ yogurt treated with Guddaim concentration 20%.

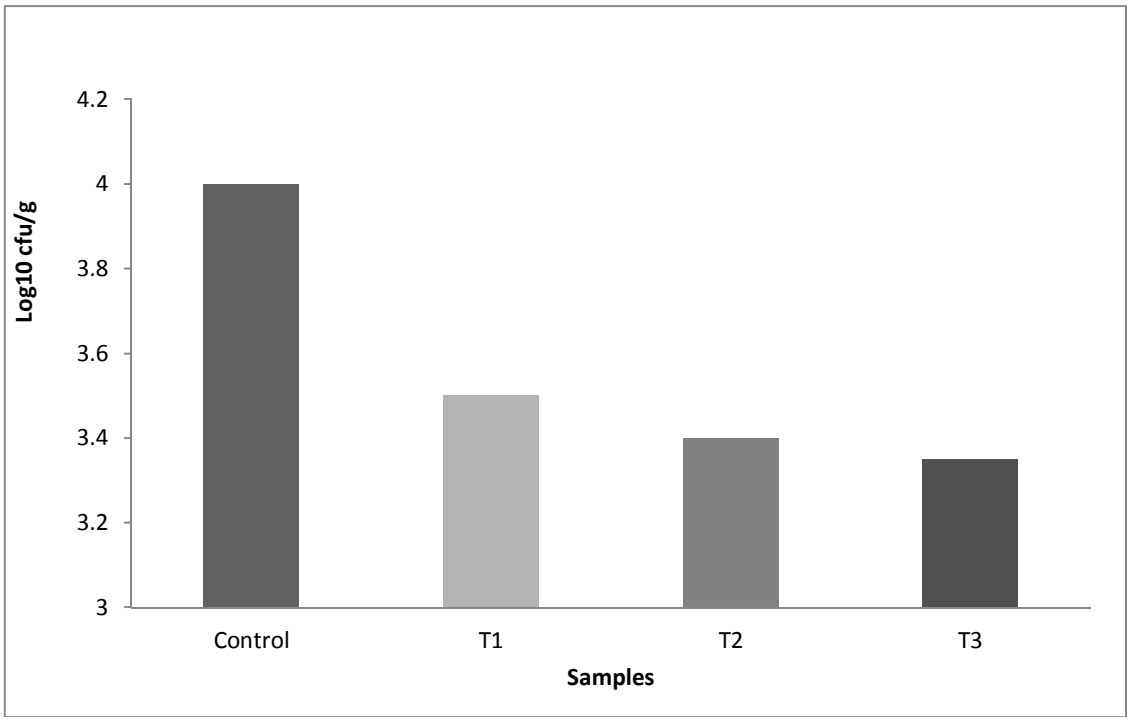

Figure 14: total viable count of bacteria of yoghurt supported with Guddaim

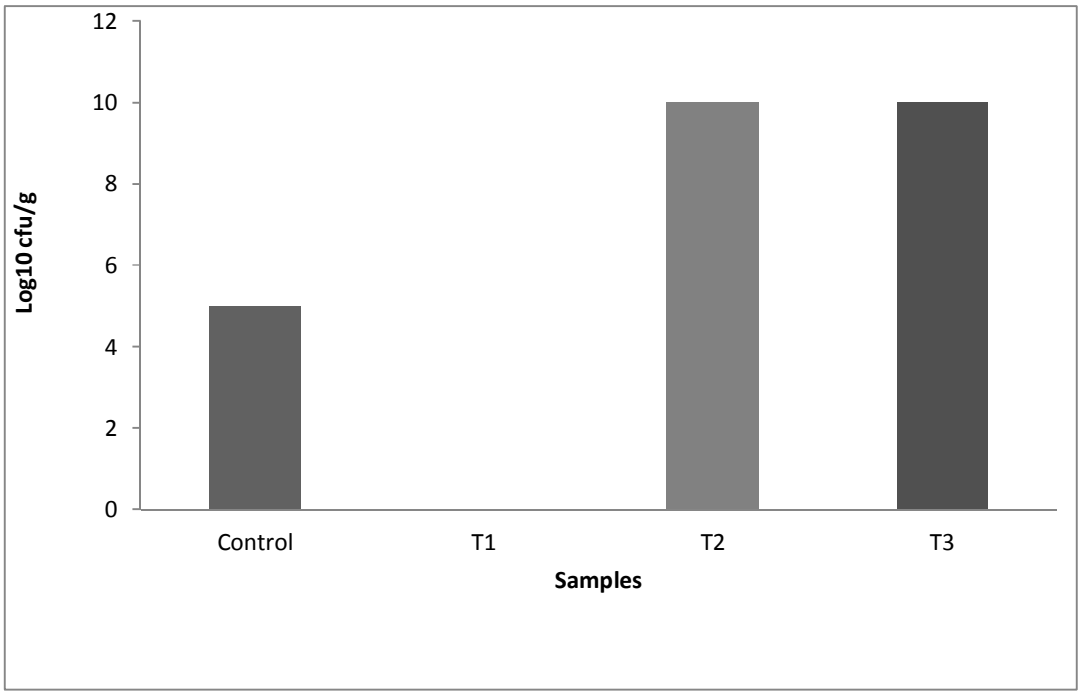

Figure 15: yeasts and moulds of yoghurt supported with Guddaim

Table 8: minerals content (mg/100g) of yogurt treated with Guddaim

Parameter	Calcium(Ca)	Iron(Fe)
Control	4.39±0.54^{e}	0.0657±0.00^{f}
T_1	19.68±0.56^{d}	0.0780±0.00^{e}
T_2	21.13±0.92^{bc}	0.1023±0.00^{d}
T_3	20.47±0.52^{cd}	0.1093±0.00^{c}
D	21.64±0.35^{b}	0.1180±0.00^{b}
R	43.44±0.61^{a}	0.1760±0.00^{a}
$Lsd_{0.05}$	1.082*	0.0005626*
SE±	0.3512	0.0001826

Values are mean±SD.

Mean value(s) bearing different superscript(s) in a column are significantly different ($P \leq 0.05$).

$T_{1\equiv}$ yogurt treated with Guddaim concentration 10%.

$T_{2\equiv}$ yogurt treated with Guddaim concentration 15%.

$T_{3\equiv}$ yogurt treated with Guddaim concentration 20%.

Table 9: Sensory evaluation of yogurt treated with Guddaim

Quality attributes	Control	T_1	T_2	T_3	$Lsd_{0.05}$	SE±
Colour	3.55 ± 1.47^{a}	3.10 ± 0.79^{b}	3.70 ± 0.92^{a}	3.65 ± 0.88^{a}	0.6603^{NS}	0.2344
Flavour	3.45 ± 1.05^{a}	3.30 ± 0.86^{a}	3.35 ± 0.93^{a}	3.85 ± 0.99^{a}	0.6054^{NS}	0.2149
Consistency	3.85 ± 1.14^{a}	3.30 ± 1.03^{a}	3.35 ± 0.93^{a}	3.35 ± 1.09^{a}	0.6615^{NS}	0.2348
Taste	3.70 ± 1.22^{a}	3.40 ± 0.94^{b}	3.45 ± 0.94^{b}	3.60 ± 1.19^{a}	0.6807^{NS}	0.2417
Aftertaste	3.15 ± 1.09^{ab}	2.80 ± 1.06^{b}	3.00 ± 0.86^{ab}	3.55 ± 0.89^{a}	0.6161^{*}	0.2187
Overall acceptability	3.55 ± 1.15^{a}	3.20 ± 0.89^{b}	3.65 ± 0.88^{a}	3.70 ± 0.80^{a}	0.5908^{NS}	0.2098

Values are mean±SD.

Mean value(s) bearing different superscript(s) in a column are significantly different ($P\leq0.05$).

$T_{1\equiv}$ yogurt treated with Guddaim concentration 10%.

$T_{2\equiv}$ yogurt treated with Guddaim concentration 15%.

$T_{3\equiv}$ yogurt treated with Guddaim concentration 20%.

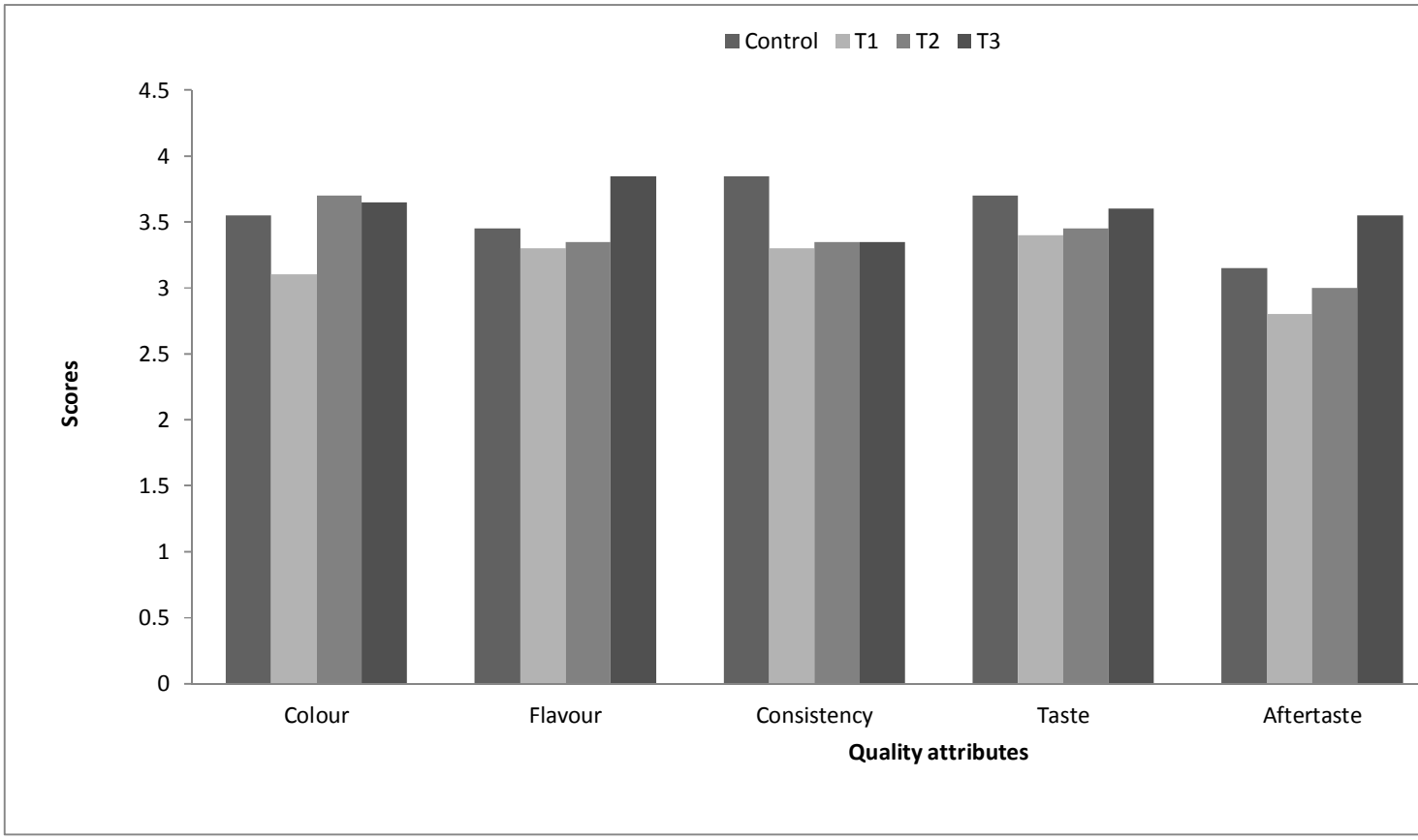

Figure 16: Sensory evaluation of yoghurt supported with Guddaim

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1-From the results obtained in this study ,it can be concluded that Guddaim fruit was found high nutritional value.

2-Yogurt made from this fruit was not better than control in terms of chemical and physicochemical characteristics probably because of the concentrations used (10%, 15%, 20%).

3- Calcium was found high inT_1, T_2 and T_3.

4- The overall acceptability was high in T_3.

5.2 Recommendations

1-Usage of Guddaim in production of yogurt with higher nutritional value an acceptable to consumer.

2-The product has high levels of calcium and iron, for that recommend it for preschool children and mothers.

3-Awareness of consumers about medical and nutritional benefits of Guddaim.

4-Further studies are needed.

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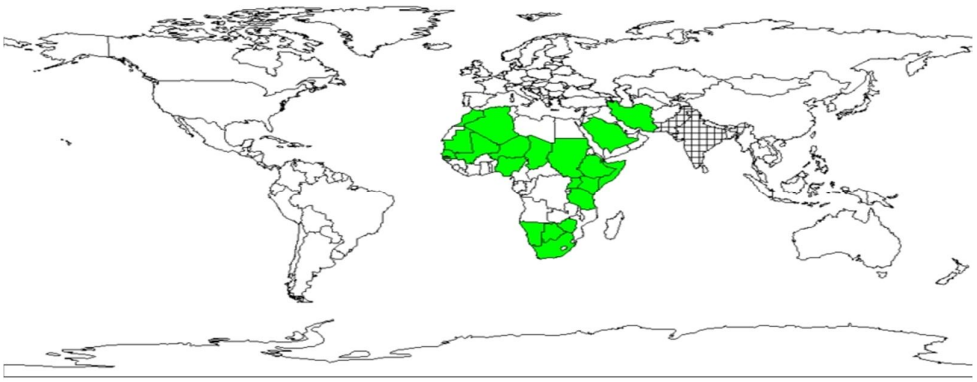
APPENDICES

Appendix 1: Guddaim shrub

Appendix 2:*Grewia tenax* fruits

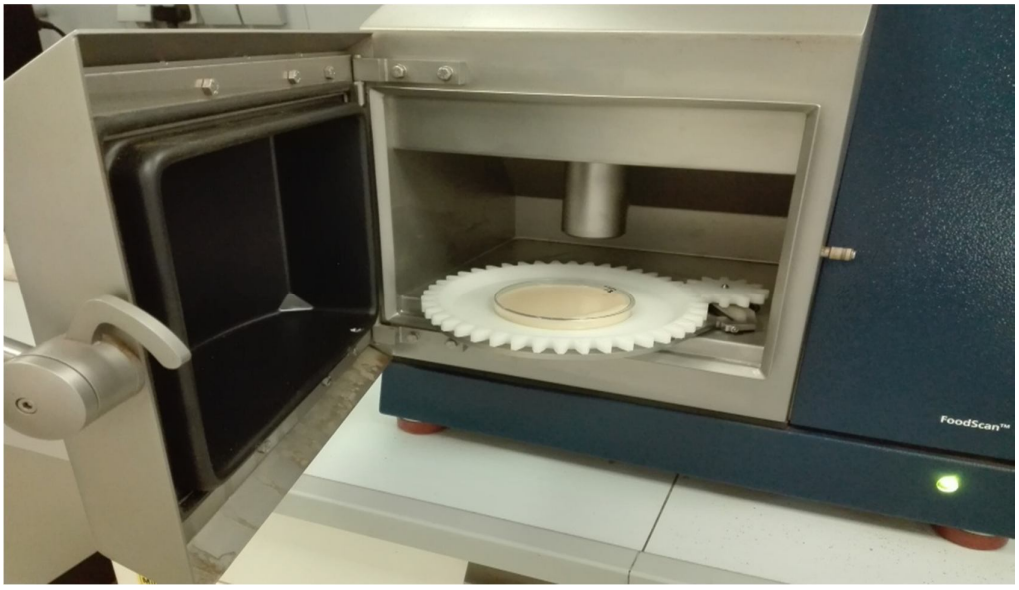
Appendix 3:*Grewia tenax* natural growth.



Appendix 4:*Grewia tenax* distribution

Native range:

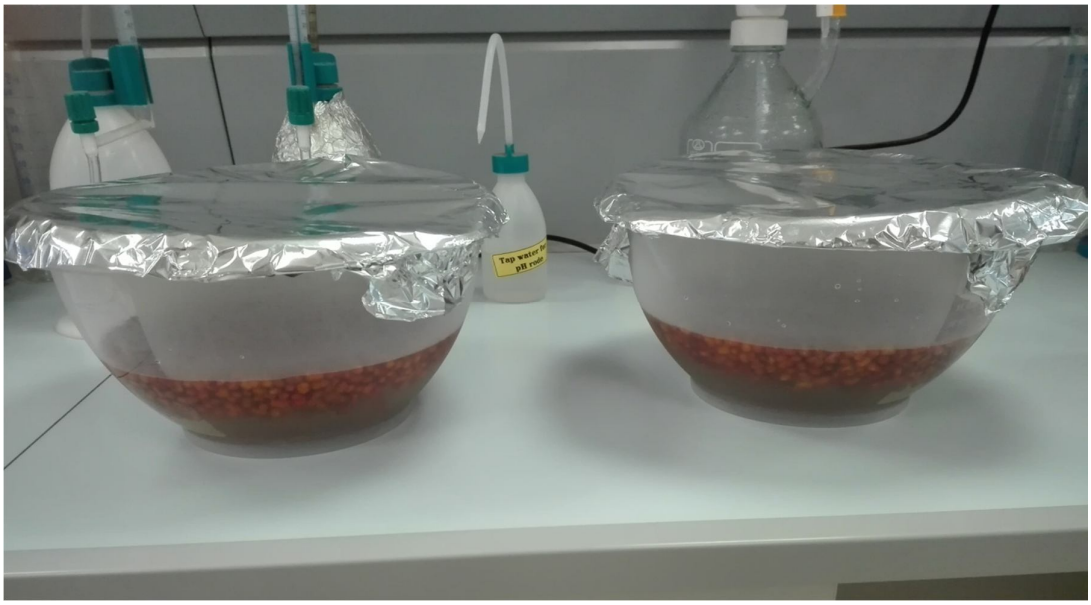
Exotic range:



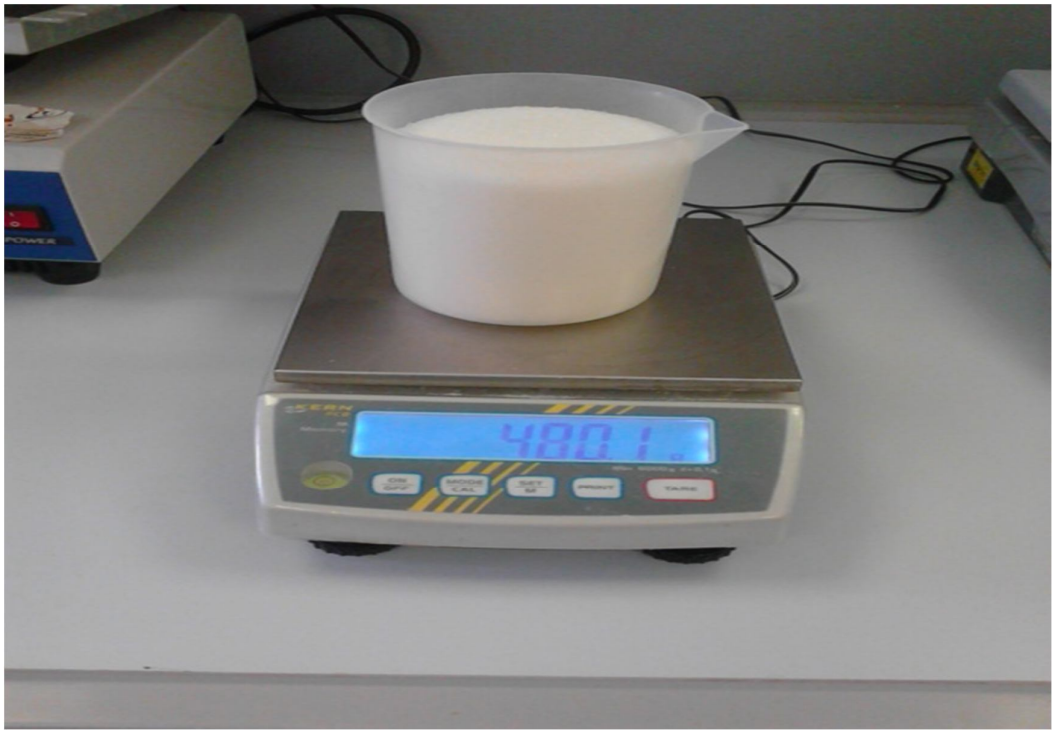
Appendix 5: Food Scan apparatus

Appendix 6: Titroline

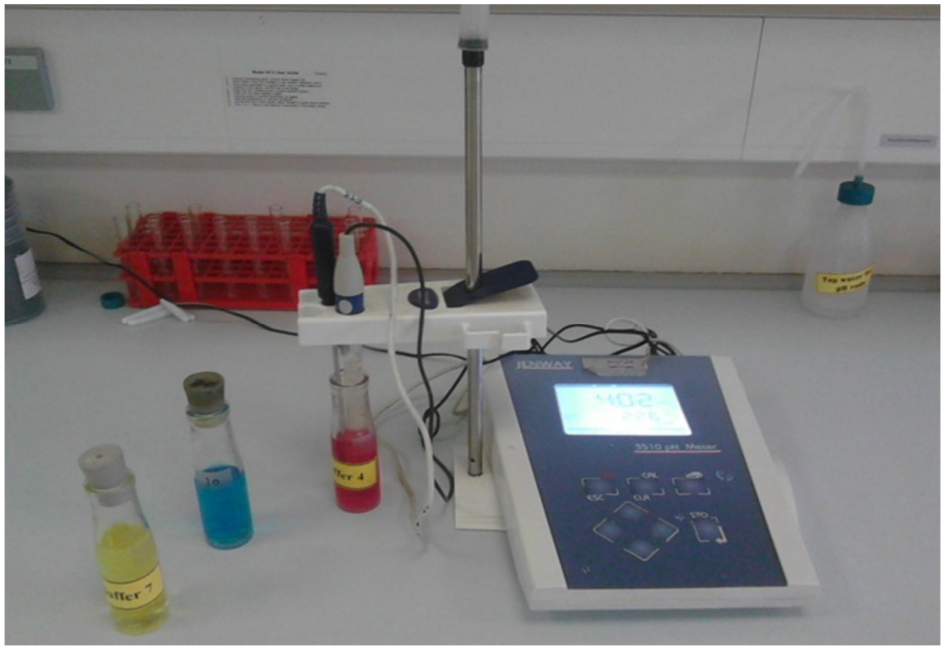
Appendix 7: Thermomixer



Appendix 8: Guddaim soaking

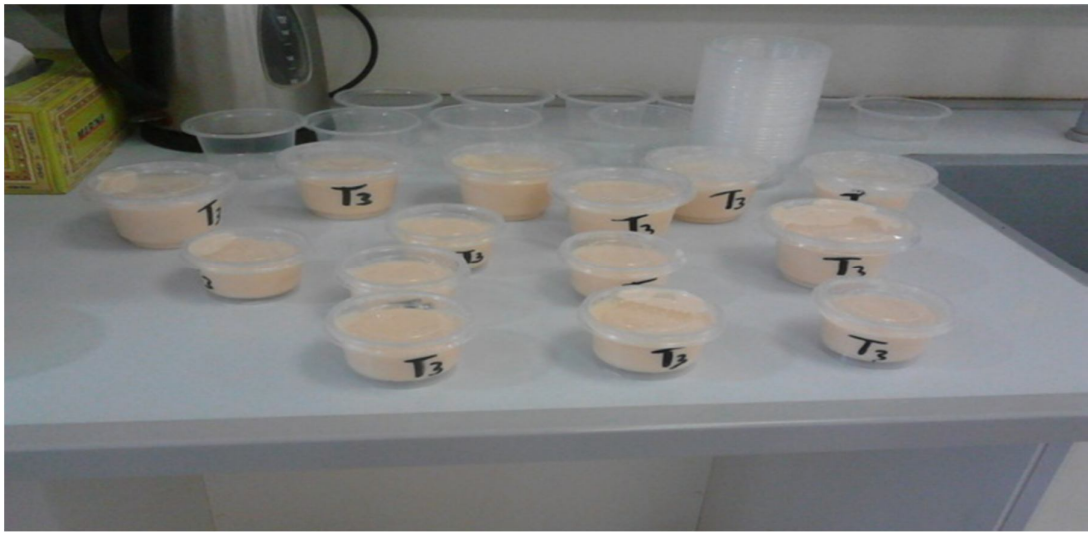


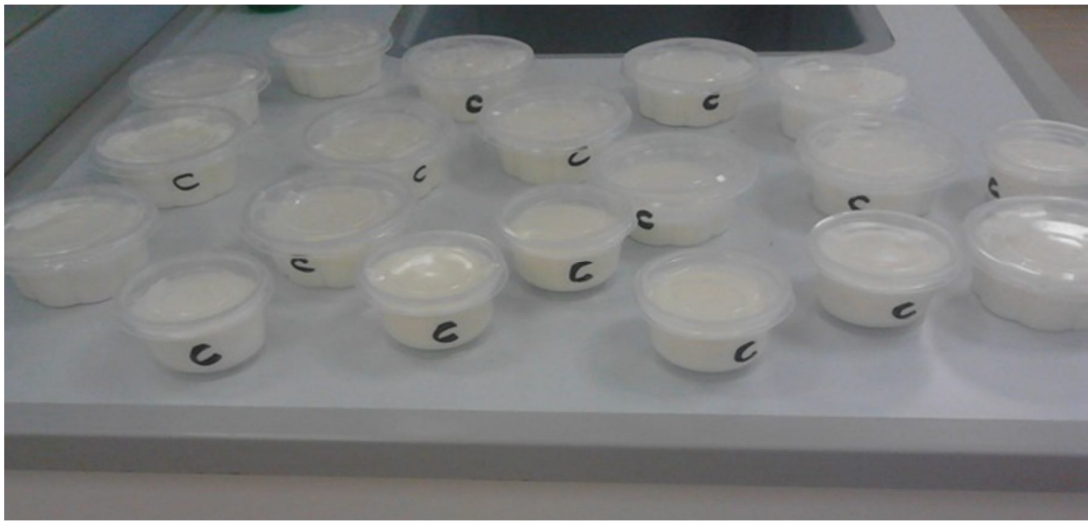
Appendix 9: Balance



Appendix 10: pH meter

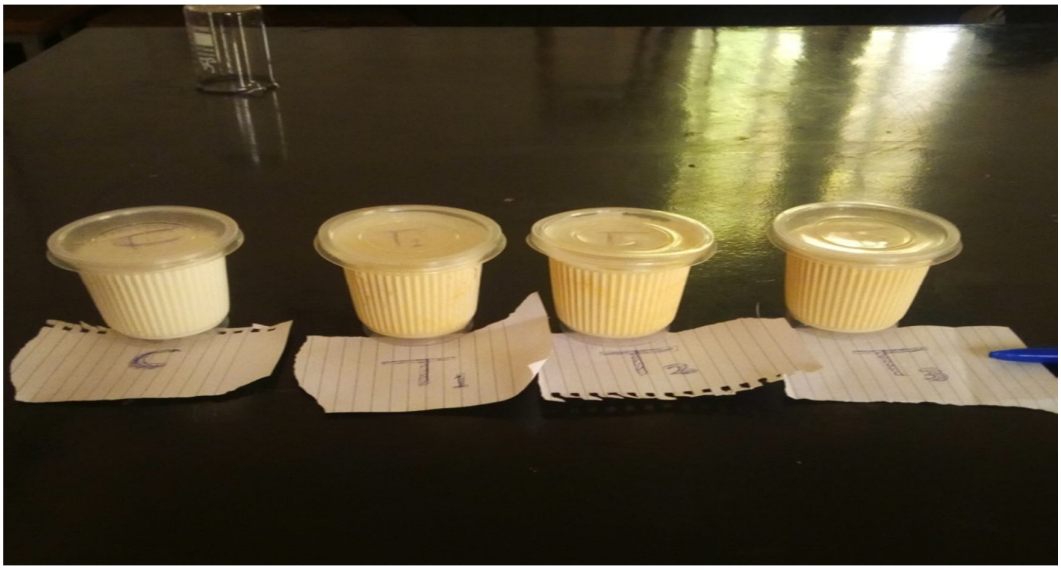
Appendix 11_a: Samples of Guddiam Yogurt





Appendix11 ь: Samples of Guddiam Yogurt

Appendix 13: Guddiam juice



Appendix 14: Sensory evaluation