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Utilization of Sweet Potato Roots in Jam Production

إستخدام جذورالبامبي في إنتاج المربى

By

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الآية

بسم الله الرحمن الرحيم

قال تعالى:

(وَهُوَ الَّذِي أَنْزَلَ مِنَ السَّمَاءِ مَاءً فَأَخْرَجْنَا بِهِ نَبَاتَ كُلِّ شَيْءٍ فَأَخْرَجْنَا مِنْهُ خَضِرًا نُخْرِجُ مِنْهُ حَبًّا مُتَرَاكِبًا وَمِنَ النَّخْلِ مِنْ طَلْعِهَا قِنْوَانٌ دَانِيَةٌ وَجَنَّاتٍ مِنْ أَعْنَابٍ وَالزَّيْتُونَ وَالرُّمَّانَ مُشْتَبِهًا وَغَيْرَ مُتَشَابِهٍ انْظُرُوا إِلَى ثَمَرِهِ إِذَا أَثْمَرَ وَيَنْعِهِ إِنَّ فِي ذَلِكُمْ لَآيَاتٍ لِقَوْمٍ يُؤْمِنُونَ)

صدق الله العظيم

سورة الأنعام الآية (99)

DEDICATION

This dissertation is dedicated to the soul of my late mother

Awidia Abdallah and my father Hamza Boshra

To my dear Brother Mohamed

To my dear sister Alia

To my dear aunts and uncles

Toall my relatives for their kind help and support.

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ABSTRACT

The main goal of this research was to encourage the industrial utilization of sweetpotato(*Ipomoea batatas*) roots as raw material for production of jam with high nutritional value in order to improve and facilitate the domestic consumption of these roots in Sudan.

The results indicated thatsweetpotato roots pulp contain high percentages of dry matter(25.72%),totalcarbohydrates(79.47%),availablecarbohydrates(70.54%). totalsugars(35.93%),non-reducingsugars(19.87%),reducing sugars (16.06%),protein(13.96%),and low percentages of crude fibre(08.93%),ash(05.17%), andfat(01.40%),on drymatter basis.Also the pulp was found to contain high percentages of calcium(322,28mg), potassium (281.26 mg), phoshorus(103.62 mg), sodium (21.66 mg),and low percentages ofzinc (00.12 mg),manganese(00.54 mg),and iron (03.38 mg).Also, the study indicated that the roots pulp could be easilyextracted after being blended by using electric blender. Theblend was found to contain appreciable amounts of total soluble solids (7%), while the hydrogen ions concentration and the total yield of the blend were about5.71 and 11.50kg respectively.After that, sweetpotato jam was prepared according to the chemical and physical characteristics of sweetpotato roots pulp, and it was found to contain high energy value (254.22Kcal/100gm), total sugars(55.92%), non-reducing sugars(44.53%), reducing sugars (11.39%), and low amounts of protein(5.38%),and fat(00.36%), and ash(1.34%). In addition to appreciable amounts of sodium (06.7 mg), potassium (65.62 mg), magnesium (00.32 mg), and calcium (97.66 mg),phosphorus(34.02 mg), iron(01.07 mg),zinc(00.67 mg)per100g.Finally, the sensory evaluation results verified the quality of sweetpotato jam samples especially those produced with pineapple flavour.

ملخص الدراسة

كان الهدف الأساسي لهذا البحث هوتشجيع الإستغلال الصناعي لجذور البطاطا الحلوة (البامبى) كمادة خام لإنتاج مربي ذات قيمة غذائية عالية لتطوير وتسهيل طريقة الإستهلاك الغذائي المثلى لهذه الجذور في السودان.

ولقد أوضحت نتائج الدراسة أن لب جذور البطاطا الحلوة تحتوي علي نسبة عالية من المادة الجافة (25.72%),الكاربوهيدرات الكلية (79.47%), الكاربوهيدرات المتاحة (70.54%), السكريات الكلية (35.93),السكريات الغيرمختزلة (19.87%) السكريات المختزلة (16.06%),البروتين (13.96%), ونسبة قليلة من الألياف الخام (08.93%) والرماد(05.17%), والدهون (01.4%), علي أساس الوزن الجاف .كما يحتوي علي نسبة عالية من الكالسيوم (322.28mg),البوتاسيوم (281.26mg),الفسفور(103.62mg), الصوديم (21.66mg), ونسبة قليلة من الزنك (00.12mg),والمنجنيز (00.54mg),والحديد (03.38mg), لكل 100جم من المادة الجافة.

كذلك أوضحت الدراسة سهولة أستخلاص لب جذورالبطاطا الحلوة بعد خلطها بإستخدام المضرب الكهربي. والمزيج وجد أنه يحتوي علي نسبة معقولة من المواد الصلبة (7%)بينما وصل تركيزأيون الهيدروجين والكمية الكلية للخليط كانت 05.71,11.50Kgعلي التوالي. وبعد ذلك تم تصنيع مربي البطاطا الحلوة بناءً علي الخواص الكيمائية والفيزائية للب الجذور حيث تميزت بإرتفاع قيمة الطاقة (254.22Kg/100g),والسكريات الكلية (55.92%),والسكريات الغير مختزلة(44.53%), والسكريات المختزلة(11.39%), ونسبة قليلة من البروتين(05.38%), والدهن (00.36%),والرماد (01.34%). هذا إضافة إلي إحتوائها على كميات مقدرة من الصوديم (06.7mg), البوتاسيوم (65.62mg),المغنسيوم (00.32mg), الكالسيوم (97.66mg),فسفور (34.02mg), حديد(01.07mg), والزنك (00.67mg).

وأخيرا أكدت نتائج التقييم الحسي جودة مربى جذور البطاطا الحلوة خاصة تلك التي أضيف لها نكهة الأناناس.

CHAPTER ONE

INTRODUCTION

Sweetpotato(*Ipomoea batatas* (L.)Lam.)iscultivated throughout thetropicsandwarm temperateregionsofthe worldforitsstarchy roots,whichcanprovidenutrition, besides energy. Theedibletuberous rootiseitherlongand tapered, ovoidorroundwithaskincolourrangingfrom white,brown, purpleorred andtheflesh colourranging from white, palecream, orange or purple.Besides,theplant isalsomuchvaluedforitsgreen tops,which areaconcentrated sourceofmanyessentialvitaminsandminerals. Although Chinaisthelargestproducer ofsweetpotatoes, accountingformorethan80%oftheworldsupply,only 40 %oftheproductionis usedforhumanconsumption and industrial uses, while, the rest goes as animal feed. Sweet potatoes are considered as one of the most important food crops of manduetothehealth contributingprinciplesinthe tubersandleaves **(Padmaja*et al.*, 2012)**.

Sweetpotato is a large, starchy, tuberous root vegetable. Each and every part of the sweetpotato,especially the tuber is beneficial for society.This dicotyledonous plant belonging to the family Convolvulaceae is scientifically known as*Ipomoea batatas*L.Sweet potato is now being recognized as a health food due to several of its neutraceutical components and carotenoids. Sweet potato contains magnesium, the key mineral for de-stressing and good mood. It also promotes artery, bone, muscle, and nerve health. Sweet potato varieties may be ‘firm’ or soft(**Milind and Monika,2015)**.

The Sudanese name for sweetpotato is Bambie.The sweet potato is a herbaceous perennial vine with alternate heart-shaped. The food ranking system also showed sweet potato to be a strong performer in terms of traditional nutrients. This root vegetable has been used in the traditional system of medicine for Alzheimer's disease because which is rich in beta-carotene. A very good source of vitamin C and manganese, as well as a good source of copper,dietary fiber,vitamin B6,potassium and iron. Moreover, poor in content of protein but which is present contains several of essential amino acids like leucine,lysine,phenylalanine,valine,tryptophan and threonin .Sweet potatoes and its leaves contain antioxidant,phenolic components, have potential value as chemo-preventative materials for human health. Both beta-carotene and Vitamin C are very powerful antioxidants that Work in the body to eliminate free radicals.The biofortification of staplefood crops is a new public health approach to control vitamin A, iron and zinc deficiencies in poor countries. Beta-carotene is the most available important source of pro-vitamin A in the diet of most people living in these countries**.**Orange-Fleshed sweet potatoes which are naturally rich in p- caroteneare an excellent food source of pro-vitaminA. Sweetpotato could be a goodsource of protein ingredient for food processing as it possesses good solubility and emulsifying properties**(Abdel-Rahman,2012).**

Objectives

1. To study the nutritional value of sweet potato roots.
2. To study the suitability ofsweetpotato roots for Jam production.
3. To evaluate the chemical, physico-chemical and organoleptic characteristics of the end product.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Sweet potato roots

2.1.1 Taxonomical classification of sweet potato

Kingdom: Plantae

Subkingdom: Tracheobionta

Super division: Spermatophyte

Division: Sagnoliophyta

Class: Magnoliopsida

Subclass: Asteridae

Order: Solanales

Family: Convolvulaceae

Genus : Ipomoea L.-morning glory family

Species: (I.batatas(L.)**(Milind,and Monika 2015)**.

2.1.2 Classification of sweetpotato according to flesh colour

Sweetpotatofleshhaveavarietyofcolours.Generally,thereiswhite,light-pink, dark-purple,redandcream, orangeandyellow fleshedsweetpotatoes.Thetwo mostcommon fleshcoloursarewhiteandorange.Apartfromthedifference inthecolour oftheskin,thereseveralspecific differenceswiththesesweetpotatoes. Whitefleshed sweetpotato is considered to be sweeter relative to the orange fleshedsweetpotato andtheorange sweetpotato isknown to containmorebeta-carotenethanthewhitesweetpotato.Thewhitesweetpotatohasasofterskincomparedtoo rangesweetpotato.Unlike thewhitesweetpotato,theorangesweetpotatohasaharder andsolidtexture.The orangesweetpotatohasdarkenskinthanthewhitesweetpotato**(Masango,2014).**

2.1.3 Common name for sweet potato

Sweetpotao(English);batata,boniato,camo-te(Spanish) kumar(prtu) ;kumara (Polynesian);and Cliera abana, protector of the children(Eastern Africa) ;and kara-imo, china potao**(Bovell,2007)**.

2.1.4 Sweet potato morphology

Theabovegroundpartismadeupofleaves andvines.Totalnumberofleavesper plantvariesfrom60to300andtheleavescomeindifferentshapes.Sweetpotatogenotypei smade upofdiverseclassesofleavesranging from erect,bushy,andintermediatetospreading;basedonthelengthofthevinesLeavesarerich invitaminB,β-carotene,iron,calcium,zinc,andprotein**(Masango,2014)**.

Theleavesandvinescanyieldbetween20 to80tonsperhectare.Leafpetiolesandvines providechannelstotranslocatecarbohydratesthroughouttheplant.Vinesformashallow andhorizontalcanopythatresultsintothecropgrowingvery fast;coveringalargeground area thereby rapidly maximisinginterceptionof incomingsolar radiation. Somecultivars alsohavestemswithtwiningcharacteristics. Thestems oferectcultivarsareapproximately 1metrelong,whilethespreading stemscanbemorethan5metreslong. Thestemcolourcanbe green,partially purple orentirely purpleduetothepresenceofanthocyaninand cultivar type**(Masango, 2014)**.

2.1.5 Soil and irrigation

Sweetpotatoes are grown on a variety of soils, but well-drained, light- and medium-textured soils with a pH range of 4.5-7.0 are more favorable for the plant.Application of phosphorous and potassium are recommended during field preparation.The efficient method of irrigation of sweetpotato is drip irrigation**(Milindand Monika, 2015)**.

2.1.6 Pests and diseases

Sweetpotato storage root and vine are attacked by various nematodes and insect pests. *Meloidogyne* spp. (root-knot) and *Rotylenchulusreniformis* are the major known nematode pests of sweet potatoes in the tropics). *Cylasformicarius* Fab. (Sweetpotato weevil) is a major pest in most sweetpotato growing countries. *Euscepespostfasciatus* (Fairm.) (Scarabee), is a serious pest in the drier parts of South America, the Caribbean and the Pacific**(Milindand Monika, 2015).**

2.1.12 Storage

Sweetpotatoes should be stored at 80 to 90% relative humidity and 55°F· Store in a cool, dark place with good ventilation. Use within 2 weeks. Do not store in the refrigerator**(Milindand Monika, 2015).**

2.1.9 Geographical distribution

It is widely cultivated in tropical, subtropical and temperate regions of the world.It is cultivated in China, Uganda, Nigeria, Indonesia, Tanzania, Vietnam, India, United States**(Milindand Monika,2015)**.

2.1.6 Cultivation and collection

The crop is widely grown in tropical, subtropical and temperate areas between 40° N and 32° S. The plant does not tolerate frost. It grows best at an average temperature of24 °C (75 °F), abundant sunshine and warm nights.

Annual rainfalls of 750–1,000 mm (30–39 inch) are considered most suitable, with a minimum of 500 mm (20 in)in the growing season. Heavyrainfall, high temperature and excess cloudiness encourage vegetative growth. In sweet potato, close spacing is generally recommended to achieve maximumroot yield.Though sweet potato covers the soil quickly, weeding is necessary, particularly, in the early stages ofthe crop growth**(Milindand Monika, 2015)**.

2.1.7 Variety

2.1.7.1 Orange flesh sweet potato

Normally sweetpotato flesh colour is white, but some of the cultivars have orangeflesh.The orange fleshed sweetpotato contains-carotene which is a precursor of vitamin A. Sweetpotato tubers contain -carotene up to 20 mg 100 g-1 fresh weight.One cup of cooked sweetpotato can provide 30 mg (50,000 IU) of -carotene, whereas 23 cups of broccoli are requiredto provide the same amount of -carotene**(Nedunchezhiyan*et al.*,2012)**.

2.1.7.2 Purple flesh sweetpotato

Purple-fleshed sweetpotatoes have purple color in the skins and flesh of the storage root due to the accumulation of anthocyanins. Anthocyanins are natural soluble food pigments and contribute to the red, blue and purple colouration of leaves, flowers and other parts of the plants. Anthocyanins have applications in pharmaceutical and cosmetic industries due to its bright colour, non-poisonous nature, rich nutrition, safe and health care function. In recent years, interest on anthocyanin hasincreased due to possible health benefits Anthocyanins from purple sweetpotatoes have high heat and light stability. First noted that sweetpotato anthocyanins are effective natural food colorants for preparation of beverages. Sweet potato anthocyanins are comparable to that of red cabbage in terms of their quality as natural food colorants. It wasreported that purple fleshed sweetpotatoes are used in juices, alcoholic beverages, jams, confectioneries, bread,snacks and noodles.The recent findings of the radical scavenging, antimutagenicity and efficacy against liver disease of sweet potato anthocyanins, indicated that purple flesh sweetpotato may contribute to maintaining good health of human beings **(Nedunchezhiyan *et al*.,2012)**.

2.1.8 Acceptability

The orange fleshed sweetpotato in regions where white fleshed sweetpotato is traditionally dominant could be challenging. In South Africa, the white fleshed sweetpotato is frequently consumed; and in some rural areas women cultivate the white flesh cultivar on small backyard plots as a food security crop.The white fleshed cultivar, however, contains insignificant quantities of the β- carotene;as a result it cannot contribute to the alleviation of Vitamin ADeficiency **(Masango, 2014)**.

2.1.9 Sweetpotato production in Sudan

Among many vegetable crops,sweetpotato is well known in Sudan and is produced and consumed in the different regions. It is produced all most all the year round under irrigation in Central and Northern Sudan for market,and under the rainy season in Southern and parts of WesternSudan**(Genif, 1988)**.Generally, in Sudan sweetpotato is grown in many parts of the country by small-scale farmers with limited resources. The varieties are with low yield (6-8 tones ha-1) late maturating (6-7 months) and low value of b–carotene **(Khalafalla*et al*.,2008)**.

2.1.10 Nutritionalvalue of thesweet potato

Sweetpotato has a huge role in human nutrition, food security and poverty alleviation,especially indevelopingcountriesbecauseofitsnutritionalcomposition anduniqueagronomicfeatures.Thecropisvaluablein addressingvitaminA deficiency(VAD)whichisaseverepublichealthproblemin manydevelopingcountries,includingSouthAfrica.Sweetpotatoisrichincarotenoids(especially β-carotene),proteins,carbohydrates, minerals(calcium,iron,and potassium), dietary fiber,vitamins(especially C, folate, and B6), antioxidants(suchas phenolicacids),anthocyanins, tocopherolandsodium.Orange fleshed sweetpotato contributes 28 percent of vitamin C, 13 percent calcium, 15percent magnesium and 75.6percentzincwhichisrequiredby children between4and8yearsofageintheir dailydiets**(Masango, 2014)**.

Insomepartsof West,CentralandEastAfrica,orange fleshedsweetpotatois regarded animportant sourceofcalories. InChina, Vietnam,Korea andTaiwan,andthe Philippines sweetpotatois animportantsource ofstarch. Sweetpotatodry matter consistsofapproximately70percentstarch.Thestorageroots haveaveragecontents ofminerals andvitaminsintherecently developedsweetpotatocultivar ‘Suioh’ are117 milligrams(mg) calcium,1.8mgiron, 3.5 mgcarotene,7.2 mgvitaminC, 1.6 mgvitaminE, and0.56mgvitaminKper100 g freshweightbasis.InKorea,sweetpotato leaves arevaluedasatastyvegetable**(Masango, 2014).**

Carotenoidpigmentsareregardedas fundamentalcomponentsin allphotosynthetic organisms. These areisoprenoidmoleculescommoninall photosynthetictissues;and are dividedinto the hydrocarboncarotenes,suchas lycopene,β-caroteneandxanthophyll.Thecarotenoidsaremainly40-carbonisoprenoids, which consist of eightisopreneunits. Morethan700naturallyoccurring carotenoids have been identified**(Masango, 2014).**

Inthesweetpotatoplant,carotenoidpigments areresponsible forthecream,yellow andtheorangefleshcolouroftheroot.Theyellow andorangecolour ofsweet potatocultivars indicate high β-carotenecontent, whereas whitecultivars maycontainlittleor noβ-carotene.Carotenoids,otherthan β-carotene,identifiedin theorangefleshedsweetpotato, includealpha,beta and gammacarotenes, phytoene and phytofluence**(Masango, 2014)**.

Thesecarotenescontributemoreor less onepercent ofthetotal carotenoids.Inseveralwhitefleshedcultivars, either β-zeacaroteneor neurosporenedominates.Theimportanceofthe β-caroteneandotheractivecarotenesis characterisedby the provitaminAactivity .TheprovitaminA carotenoidsareenzymaticallyconvertedintheintestinal mucosaofhumanbodyto giveuptheretinal and eventually theretinol.Theretinol(vitamin A)isessential forvision,maintenanceofdifferentiatedepithelia,mucussecretion, andreproductioninhumans**(Masango, 2014)**.

2.1.10.1 β-carotene

β-carotenerichorange-fleshedsweetpotato(OFSP)isanexcellentsource of provitaminA.ProvitaminAoforange fleshedsweetpotatoappearsto bemore bioavailablethanthat frommostvegetables. Productionand consumptionoforangefleshedsweetpotatoisconsidered asustainablelong-term approach to address vitamin A deficiency and is used in many parts of the developingworld. InSouthAfrica, OFSPiscurrentlybeingpromotedtolowincome householdsasanalternativetosource ofβ-carotene**(Masango, 2014)**.

2.1.10.2Vitamins

Thestoragerootsconstituteessentialvitaminssuchaspantothenicacid(vitamin

B5), pyridoxine(vitamin B6), thiamine(vitamin B1), niacin andriboflavin. These vitaminsareessential intheway thatthehuman body requiresthemfromexternal sourcestoreplenish.Theyhavealsobeenreportedtocontainreasonableamounts ofVitaminE .Thesevitamins functionasco-factors forvariousenzymesduringmetabolism.Ina humanbody,VitaminB6breakdownhomocysteine,asubstancethatcontributesto thehardening of bloodvessels andarteries**(Masango, 2014)**.

2.1.10.3 Minerals

Theorangefleshedsweetpotatocontains ahighcalciumconcentrationthan other sweetpotato cultivars .Magnesium content of theorangefleshedsweetpotatois19.3mg/1009whencomparedtoothercultivars.A100 gramsofcookedportionoftheorange fleshedsweetpotatocould contribute15% (19.6mg/100g)ofthedaily requirements,incomparisontowhite fleshedwhichcould contribute10%(13mg/100g),followedby 8.5%fromcarrots(11mg/100g) forchildren under theageoffour toeightyears**,**Potassiumis another vitalmineraltothe human body,Potassiumconcentrationhas beenreportedasthemostabundant(324mg/100g)insweetpotatorootscompared totheother whitefleshedsweetpotato.Other mineralsinlow amountsinclude manganese(8.8 mg/100g),iron(14.0 mg/100g), copper(1to5.0 mg/100g) andzinc(0.3mg/100g)**(Masango, 2014)**.

2.1.11 Processingof sweetpotatointoproducts

Thetraditional methodsofprocessing sweetpotatoin most countrieshave been limitedtowashing,peelingand boiling.However,insomecommunities,the roots are washed,peeled, cutintosmallpiecesandthenlemon or tamarindjuicesparinglyadded.Thepiecesare, then, driedinthesunandmilledtogetherwithsorghuminto flourthatcanbeusedinmakingporridge. Some farmers make chips, sun dry, store and later reconstitute by addingwaterthencookbyboiling. Othersdrythegrated product, millandthen addtootherflourstomake composite flours.**FAO(2011)**developedimproved processing methodstohelpovercomesomeofthe problems associatedwithtraditional method,inorderto produce sweetpotato flour with improved odour,colourandnutritionalqualities**(Oke and Workneh, 2013)**.

In cases where rare on-farm processing of sweetpotato is done in sub-SaharanAfrica, productsmade include flourwhichismixedwithsorghumtomake porridgeandmildalcoholicbeverages frompeeled, chopped, fermented andpoundedsweetpotato.This processing isonlydonewhenthecrophasbeen harvested andtherearenootherimmediate usesforthe produce.Inmany otherareasofthedistrict,flour productionwaspopularinthe60'sbutwasabandonedin favourofmaizeflour. Thedevelopment ofprocessedproductsfromsweet potatopresentsoneofthemostimportant keystothe expanded utilizationofthecrop.Justlikewhitepotatoes, sweetpotatoesaremultipurpose vegetables. The development insweetpotatoresearchanddevelopment,hastransformedthecropfromasimplestaple foodtoanimportantcommercial cropwithmultipleuses suchasasnack,ingredient invariousfoodsand complementary vegetable.Reported thatsweetpotatoflakes(calledsweetpotatobuds)with anincreasedβ-carotene contentwereproduced in GuatemalatoconquestvitaminAdeficiency inchildren. Fresh-marketsweetpotatoescanbebaked,microwaved, broiled,grilled,andbaked.Insome countries alcoholis distilledfromsweetpotatoes. They canalsobeusedin plategarnishes, casseroles, sautéedvegetables, pasta sauces,dippingvegetables greensalads,(fresh-cut sticks), soups, stir-fry, and stews**(Oke and Workneh, 2013)**.

Theycanbeprocessedasfollows:-

(i)Dried/dehydrated:flour,flakes,chips,

(ii)Frozen:dices,slices,patties,Frenchfries,and

(iii)Canned:candied,baby foods,mashed,cut/sliced, pie fillings.

Sweetpotatoes arealsousedasaningredient incakes, icecreams, icing,piefillings, cookies, custardsand variousotherbreadproducts. Asdryingtechnology progressed,sweetpotatoesbeganto bepureedandthen driedtoproduceflakes,whichcanbeeasilyreconstituted fordirectuseinvariousproducts like mashed sweetpotato,piesandotherproducts**(Oke and Workneh, 2013)**.

Processingofsweetpotato in toproducts asfollows

2.1.11.1Driedsweet-soursweetpotato

Driedsweet-soursweetpotatowasoriginally named Delicious-SP anditisaproductthathasthesweetand sourtasteofdriedfruits. Themost acceptable productwasmadewithboiledsweetpotato slices0.3mmthickwhichweresoaked in60°Brixsyrup containing 0.8- 1.0% citricacidand dried at 65°C. The Delicious-SP preparedfromsweetpotatovariety VSP-1,whichisa "moist"typesweetpotatowithlowdry matterandstarch content,obtainedthehighestsensory scoresduetoits attractiveorange colourandsofttexture.Driedsweet-soursweetpotatocontains13,033I.U.ofvitaminAper100gwhichishigherthanbothdried mango anddried apricot**(Oke and Workneh, 2013)**.

2.1.11.2 Sweetpotatocatsup(Ketchup)

Sweetpotato catsup consists of 32.3% (w/v) sweetpotato,42%water,12.9%vinegar,11.3%sugar,1.0% salt, 0.3% spices,and food colouring(references).The rootsarewashed, trimmed, choppedintochunks,and boiled. Theboiledchunksareblendedwithwaterand otheringredients andboiledtothedesired consistency before bottling.Various sweetpotato cultivars having cooked fleshcolourswhich rangefromyellowtoorange anda“moist”texturecanbeusedforcatsup making. Sweet potato catsuphadviscosity, pH, totalsolublesolids,andintermediatevitaminAcontentcomparable to valuesfoundinbananacatsup.Inconsumeracceptability tests,sweetpotatocatsupwasrankedstatisticallyequal totheleadingbrandoftomatoandbananacatsupin termsofcolour,consistency, flavor,andgeneral acceptability. Sweetpotatocatsup storedforfourmonthsatambienttemperature wasgiven comparable sensory scorestothatoffreshlyprepared samples**(Oke and Workneh, 2013)**.

2.1.11.3 Sweetpotatojam

The sweet potatojamformula contains 20.7% (w/v) sweet potato,45%sugar,34%water,and0% citricacid andthishasproved mostacceptable bythetrainedtaste panelcompared withotherratio.Theinitialstepsin preparing sweet potatorootsaresimilartothoseforsweetpotatocatsup.Thecookedchunksareblended with water, sugar, citricacid,and optionally with flavourings. Theslurringisthencookeduntiltotalsoluble solids of68°Brixwasobtained. Due tothehighstarchcontent ofsweetpotato rootsas compared tofruits,theproportionsofsweetpotatoand sugararedifferentfromthestandard formulaof45%fruit and55%sugarinfruitjams(**Oke and Workneh, 2013)**.

2.1.11.4 Sweetpotatobeverage

Theprocessing stepsforsweetpotatobeverageinvolve washing,peeling,trimmingto removedamagedparts, steaming, extracting,andformulatingwith12%(w/v)

sugar,20%(w/v)citricacid,and232mg/Lascorbic acid asvitaminCfortification. Theformulated beverageisbottledin150mlglass containersandpasteurizedattemperatureof90to95°C.
Varioussweetpotatovarietieswereevaluated fortheir suitabilityinprocessing intothebeverage. Ingeneral,the orangecolouredbeverageispreferred toothercoloured products. Additionofthejuiceorpulpofdifferentfruits, e.g.,guava,pineapple, orPhilippinelemon,at concentrationsof0.6to2.4%(w/v)significantlyimproved aromascores.Similartojam,incorporationofartificial orange flavouring also enhanced the aroma ofsweetpotato beverage. More than 85% of consumerrespondentsrated“like”forthesweetpotatobeverage,and96%likedguava-flavoured sweetpotatobeverage **(Oke and Workneh, 2013)**.

2.1.11.5 Sweetpotatoleather

Steamed sweetpotatochunksareblendedwithwater, sugar,salt,citricacid,andoptionally withartificial fruit flavoursinprocessing sweetpotatoleather.Theslurryis thenthinly spreadonplasticsheetsanddriedina mechanical drieruntilthedesiredmoisturecontentand textureoftheproductareobtained.Aloadingdensityof4 kgslurryperm^{2}producedthe sweetpotatoleatherwhich was ratedwithhighsensoryscores forthickness,texture, andgeneralacceptability. Theproductalsoobtained scoresofover7.0forcolour,sweetness,andsourness onthe9-pointhedonic scale. Additionofpectinat0.05to0.15%w/w didnotimprove thetextureoftheproduct. Apparentlythepectincontentofsweetpotatoissufficient toproducealeatherytexturedproduct**(Oke and Workneh, 2013)**.

2.1.11.6 Confectionaries

Sweetpotato canbe made into various confectionaries includingbuns, cakes, rollsand puff-puff byutilizing doughmade fromtheparboiled andgratedtubers.

Extensivework onthishasbeen doneinGhana (**Odebode*etal*.,2008**).

2.1.11.7 Flour

Sweetpotatoflour couldbeusedforbakingonits ownoras asupplement tocerealflour,as wellasastabilizer inthe ice-creamindustry**(Odebode*etal*.,2008).**Thepossibility ofreplacingpartofthewheatflourwith sweet potatoflourformaking bakedfoodswasinvestigated bymanyworkers. Mostofthesestudiesshowed thatacceptability isreducedduetodominantsweetpotato flavor,whenhighersubstitution wasattempted. Replace mentofwheatflourupto30%wasacceptable forcakes, biscuits,muffins, etc **(Padmaja*etal*., 2012).**

2.1.11.8 Canned sweetpotato

This is common in the USA where the yellow-fleshed varieties are preferred, and the tubers are cut into large chunks, filled into cans, heated at 85°C and immediately sealed **(Odebode*et al*., 2008)**.

Cannedsweetpotatoisalsowidely availableincountries likeAustralia,TaiwanandtheNetherlands. Thepre-processing stepsintheproductionofcannedsweet potatoaregrading,cleaning,pre-heating, peelingandtrimming.Pre-heatingis adopted by immersing therootsinheatedwaterorlivesteam forsmall periods,whichhelpsin drivingofftheintercellulargases,to facilitategoodvacuum buildupincans. foundthat40secondpre-heating inlivesteam canpreventtheenzymelinkedbrowning ofsweetpotato. Peeling andtrimmingareessentialstages inthepreparation ofcanned sweetpotato(**Padmaja et *al*., 2012)**.

2.1.11.9 Noodlesandotherextrudedfoods

Sweetpotato isprocessedintonoodlesinmanycountriesof theFarEastviz.,China,Japan,TaiwanandKorea.Amajor partofsweetpotatostarchproduced inChina andKoreais utilizedfortheproduction ofnoodles. Theprocess consists in gelatinizingsweetpotatostarchslurryinabigvesselat80°C,treatingwithsulphate topreventdiscoloration and mixingwithnativedry sweetpotatostarch (5%)toform adough.Thedoughisthenfilledtolongcylindrical column(30cm×40cm)andpressedtoextrude thedoughinto stringsintohotwater.Thisisthenseparatedmanually to preventadhesion.Thestringsarethensuddenly puttocold water,when theoutsidehardensandstickiness isreduced. Thenoodles arethendriedslowlysothatbothinsideand outsidegetdry (**Padmaja*et al.*, 2012)**.

2.1.11.10 Starch

Starch can be produced from sweetpotato in the same way as from the other starchy roots except that the solution is kept alkaline (pH 8) by using lime, which helps to flocculate impurities and dissolve the pigments. Sweetpotato starch is used in the manufacture of starch syrup, glucose and isomerized glucose syrup, lactic acid beverages, bread and other confectionaries, as well as distilled spirits called shochu in Japan. Noodles and isomerized saccharides as a sweetener for soft drinks are also made from sweetpotato starch in China, Japan and Vietnam **(Odebode*et al.*, 2008)**.

Sweetpotatostarchiscommerciallyutilized fortheproductionofanumberofcommodity chemicalslikecitricacid, monosodiumglutamate,microbialenzymes etc.whichare usedinthefoodindustry. Mostoftheseareproduced on smallscaleinChinaandJapanwhere sweetpotatostarch is industriallyproduced.The starchisfirst convertedtosugars andfermentedtocitricacidby*Aspergillusniger***(Padmaja*etal*.,2012)**.

2.1.11. 11Frozensweetpotatoes

Lowtemperature storage ofsweetpotato is practiced in developedcountries only, as thecostisprohibitive for adoption. Sweetpotatoesarefrozenas wholerootsor sliced cubes,pieces oraspastes. Therootsareoftenblanched in waterorwithsteam at10psipressure(116°C) to inactivatetheenzymes associatedwithbrowning, offflavor development etc.Steamblanchingwasreportedasthebest method, as itdoesnot lead toasoggyproduct. Theslices/cubes arepackedinplasticbags and blastfrozen at40°C. Thewashedrootsare sometimes steamed,crushed,mixed with35%sugar(w/w)and filled to plasticbagsunderpressurebeforeblastfreezing at-40C ° . Frozensweetpotatoproductsarewidely popularinJapan**(Padmaja *et al*.,2012)**.

2.1.11.12 Wineandbeerfromsweetpotato

Yellow, red and black coloured beverages like beer (sparkling liquor) and wine are being sold in the Kyushu Province in Japan prepared from anthocyanin-rich sweetpotato, of Kawagoe in Japan has been producing sweetpotato beer from roast local sweetpotatoes since1996. It contains7% alcohol and tastes like something between beer and wine, with a faint sweetness **(Odebode*et al*., 2008)**.

2.1.11.13 Sweetpotatoasanimalfeed

Thevolumeof freshrootsprocessed asfeedinIndonesiawasrelatively lowandtheuseofunmarketable freshroots(verysmall size,damagedbypests/diseases) wasmostcommonin productionareas.Moreover, sweetpotato foliageasfeed forlivestockhasbeengaining importance**(Oke and Workneh, 2013)**.

Both roots and tops apart from being used fresh, could be made into a dried meal and fermented silage and fed to livestock, including pigs, cattle and poultry. This use is quite significant in China, the USA, Taiwan and India**(Odebode*et al*.,**

2008).

2.1.11.14 Sweetpotatopuree

Sweetpotatopureeis a primaryprocessedproductfromthe roots,whichisuseddirectly asababyfoodorusedfor mixingvarious fooditems likepatties,flakes, reconstituted chips,etc.Highqualitypureecanbemadefromwhite, cream or orangefleshedsweetpotatoes andalsofrom tubersofany sizeorshape.Pureemakingalsoensuresroundtheyearavailability and betterstorage life.Theinitialprocess involvedmorecookingoftheroots, peelingandthenmashing.Theprocesswas subsequently modifiedthroughacontrolledalpha-amylase process,wherecommercial alpha-amylasewasaddedtoa portionofthepureeforenablingpartial hydrolysisofstarch. Theenzyme treatedfractionwas thentreatedwiththe remainingpuree**(Padmaja *et al.*,2012)**.

2.1.11.15 Sweetpotatoflakes

Aprocedurefortheproductionofsweetpotatoflakes,consistingofwashing, cookingcooking,mashing anddryingonsteam heateddrum dryers. The dehydratedflakes can be reconstitutedto mashedsweetpotatoorincorporated intovariousfoodproductslikepastries,cakes,bread,biscuits,etc.theratioofsolubletothei nsoluble solidsinsweetpotato pureedecidedthefinalquality oftheflakes produced. The high content ofsoluble solids in thesweetpotatoflakes resultedinlowwaterrequirement torehydratetheflakes. Further,theflavouralsoimproved with increaseinthe proportionofenzymetreatedpureeinthemash. The high content ofsoluble solids in thesweetpotatoflakes resultedinlowwaterrequirement torehydratetheflakes.Theearlier processwasfurthermodifiedforpureepreparation using addedalpha-amylases topartiallyhydrolysethestarchand increasethesoluble solidscontentofpuree.The hydrolyzed pureewasthenaddedtothecontrolpureeandsubjected to drum drying.Observedthatthe quality ofdehydratedsweetpotatoflakesdependedonthe variety ofsweetpotatoandforeachvariety,theprocess parameters havetobeoptimized**(Padmaja*et al.*,2012)**.

2.1.11.16 Sugarsyrups

Sweetpotatostarch isconverted toglucosesyruporhighfructose syrupforuseinconfectionery industries,pharmaceutical applications, etc.Microbialenzymeswithhighconversion efficiencyareavailabletoeffecttheliquefaction andsaccharificationreactions, which haveadvantagesoftheearlier acidlinkedhydrolysis**(Padmaja*et al.*,2012)**.

2.1.11.17 Non-alcoholicandalcoholicbeverages

Non-alcoholicbeveragehasbeenpreparedfromcream ororangefleshedvarietyofsweetpotato bymixingthe cookedandmashedpulpofsweetpotatowithpulpofripe mangoorfruitjuicesfromorange,lemon,pineappleetcin India**(Padmaja*et al.*,2012)**.

2.1.11.18 Alcoholicbeverages

Shochu'is traditionaldistilled liquor made from sweetpotatoorothersourceslikerice,barley,buckwheat,etc. The processconsistsinfirstpreparingafermentationbroth from ricebycrushingwhiterice,steeping inwaterfor3-4h, steaming, cooling and then adding seed 'Koji' to the steamedrice,asastarter.Thestarter'Koji'contains*Aspergillusniger*or*A.Kewachii* andthemouldgrowthisfacilitatedat38-40°Cfor24hfollowedby18hfermentationat34-36°C.The'Koji' isthenmixedwithtraditionalyeast, *Saccharomycescerevisiae*and adequate water. The seedmashafter5-7daysofincubation at25-30°Cisaddedto steamedsweetpotatoslurry.Furtherincubationat30°Cfor10-12 daysyields abroth having 13-15% alcohol,whichis distilledandblendedto form20-40%alcohol(**Padmaja *et al.*,2012**).

2.1.11.19 Dehydratedchipsandflour

Sweetpotato rootsaredehydratedtoenhancetheshelflife ofstoredroots. Thechipsarefurtherpowdered toflourand usedformakingmany snackfoods,Theroots areeither peeledorunpeeledandslicedfordrying.Discolourationof driedchipsisaproblem withcertaincultivarshavinghigh activityofpolyphenoloxidasesandhigherlevelsofphenols. thebrowningtendency ofsweetpotatowascorrelated onlywith thephenolic content,whileothersfoundthatPPOactivity wasalsocorrelatedwithbrowning potentialofsweetpotato.Theprincipal phenolicsofsweetpotatoviz.,chlorogenic acidanditsisomerswereeffectivelyoxidizedbysweetpotatoPPO,resulting inbrowningintheprocessedproduct.Extensivedrying ofsweetpotatoispracticed inChinatoproducedriedchipsforitsfurther useinstarch,noodle andalcohol factories. Dampweather andprolonged dryingperiods cancause microbialcontaminationofthechips.

Driedsweetpotatocubeshavebeendevelopedinthe Philippines,usingafabricated sweetpotatoslicer. Thecubescanbecookedeitheraloneorwithother ingredientslikecoconutmilk,rice, sugarand vanillato makeatraditionaldishcalled‘guinataan’.Orangefleshed sweetpotatoeshavebeendicedintolongstripsandsoaked in2%metabisulphite(w/v)priortocookingin60°CBrix sugarsyrupcontainingcitricacid(0.8-1.0%).Thesewere thendriedandpackedtomakeaproductlikesweetpotato candy. That processing operationsfordrychipproductiononlyslightlyaffected the chemicalconstituentsofsweetpotato.Polyethylenesacks werefoundtobethebestpackingmaterial,permitting6 monthsstoragewithoutmicrobialorinsectdamage**(Padmaja *et al.*,2012**).

2.1.11.20 Friedsweetpotatoproducts

Sweetpotatorootsaretransformed intomorestableedible productslikefriedchips,crisps,French fries etc.,whichare verypopularinJapan,USA,China,Netherlands, Peruetc. Therootsarepeeled,slicedintothinchipsanddeepfat- friedtoobtainfriedchips Discoloration duringfryingat hightemperature duetoMaillardreactionisverycommon withcultivars havinghighamino acidandsugarcontents. Sugarcoatedfriedchipsarepopularin Japan,whilesalted orspicychipsarepreferred inPapuaNew Guinea,BangladeshandPeru.Thequality isimproved through treatments like blanchingfor 2 minat 93°Cin boilingwateror a solution ofsodiumacidpyrophosphate (0.5-0.75%w/w)or diffusionextraction ofsugarstoeliminatetheproblemof browning, etc.theglucose and fructosecontentofthesweetpotatoslicesdetermined the extentofbrowning offriedchips,ratherthanthesucrose content**(Padmaja *et al.*,2012**).

Thelength offryingisinfluenced bythemoisture contentofthechipsandthetemperatureofcookingoil.Fresh/ blanchedchipshavingaround50%moisturetakesapproximately4.5minat138°C.The yieldofchipsisaround40%oftheweightofprecooked peeledroot.Highertemperatureoffryinghasbeenreportedtoresultindarkcolouredchips. Highmoistureandlowdrymattercontentinthe freshslicesleadstohigheroilretentioninthefriedchips. Reductionintheoil retentioninfriedchipsmadefrompartiallydriedblanched chips.Leadtochip hardnessandlackofcrispness.Blanchingandor freezingand thawingof the sweetpotato slicescouldreducethehardnessofchips. Packagingof fried chipsin moistureproof packsis essentialtopreventleatherinessinthechips**(Padmaja *et al.*,2012)**.

2.1.12 Sweetpotatoleaves ashumanfood

Sweetpotatoleaves, though arich source ofvitamins, minerals andprotein hasbeenmuch lessusedasahuman food.Sweetpotatogreentipsareusedasavegetablein partsoftheworld.The nutritivevalue ofsweetpotatoleaveshasbeenattributed tothehighcontentofantioxidantsespeciallyphenoliccompounds inthem.Thevariousphenolicfractionshavebeencharacterised fromsweetpotato leavesandthecaffeoylquinic acidderivativeshavebeen associatedwiththeantimutagenic effectoftheleaves.Thehighcontentoflutein(-xanthophylls) in sweetpotatoleaves,whichhasgoteyeprotectant effect. Lutein,presentto the extentof29.5mg100 g^{-1}fresh weight wasmorethanthelevels present inaround 120fruitsand vegetables**(Oke and Workneh,2013)**.

Thecooking ofyoungshootsofsweetpotatohasbeen reported todecreaseitstotalproteinfrom 3.7%to2.5% (freshweight basis (fwb) duringaperiodof4min.Similar decreases havebeen reported inthecase ofAmericanandAsiansweetpotatovarietiesalso.Leachinglosses ofascorbic acid,carotene andmineralshavealsobeen reporting duringcookinginwaterfor4min.thefresh leaves ofsweetpotato containedaround49.6mg100g^{-1}(fwb)ofcaroteneand open sunlight led to96% lossincaroteneand98%lossin vitaminC. Blanching sweetpotato leaves inboilingwater for50secondfollowed bydryinginanenclosedsolardrier retained34%ofcarotene**(Oke and Workneh,2013)**.

2.1.13 Novelfoodproductsfrom sweetpotato

Sweetpotatohasassumedgreatsignificanceinrecentyears asahealthfoodduetothevariousbioactiveprinciplesin it. Despitebeinga carbohydraterichfood,sweetpotatois reportedtohavealowglycaemicindex(<55),suggesting itsuseasafoodfordiabetics. Sweetpotatoesalsopossessantidiabetic activity andthecomponentscontributing tothiseffecthavebeenisolatedandstudiedfromwhiteskinnedvarieties.Thepossibilityof developingpasta fromsweetpotato.Itwasfoundthathighprotein pastacouldbemade from sweetpotatousingproteinsources likewhey protein concentrate ordefattedsoyflour Useoforange fleshedsweetpotatovariety, inadark orangecoloured pasta.Whichhadlow starch digestibility andhighresistantstarchcontent,besideshigh carotenecontent. Scanningelectronmicroscopyindicated the tightnetwork formationbetween starch and whichprevented theaccessofalpha-amylasetostarch. Lowglycaemicfoodsrichindietaryfibrehavebeen recognizedto haveprotective cancer, colon diseases**(Padmaja *et al.*,2012)**.

Products were developedfrom sweetpotato flour usingdietaryfibresources likeoatbran,wheatbran andricebranasadditives.Itwasfoundthattheproducts had lowin*vitrostarch*digestibilitycoupledwithhighresistantstarchcontent.Producedextr udedsnack foodsfromblendsofsweetpotatoflourwithdefattedsoy flourandreportedthathighscrewspeedcoupledwithlow diediameterfacilitatedlysineretentionbutincreasedthe browing index **(Padmaja *et al.*,2012)**.

2.1.14 Intermediaryfoodproducts

Sweetpotatoisprocessedintojams,inthePhilippines, makinguse oftheavailablewater solublepectinin theroots.Theprocess consistsofcooking amixtureof20.7%sweetpotato, 45%sugar,34%waterand0.3%citricaciduntila solidscontentof68°Brixwasreached.Sensoryevaluation of fruitflavouredsweetpotatojamscored roots.Highfor taste,but gellingconsistencywasslightly softerthanfruitjamdueto thehighcontentofstarchintheSweetpotatojamis alsoprepared on asmallscaleinpartsofChina**(Padmaja *et al.*,2012*)***.

Thehighcarotene content oforangefleshed variety'KamalaSundari'ofsweetpotatois utilizedtodevelop naturallycolouredjaminBangladesh. Sweetpotatoisprocessedintocandiesinpartsof Japan andChina, Thepalecreamorpurplefleshed cultivarsareusedforthispurpose.Thesweetpotatomashis mixedwithbarleymaltfor1.5hat55°Ctoenablethe hydrolysisofstarchtomaltoseanddextrin.Jellyis preparedfromorangefleshed sweetpotato(variety:Kamala Sundari) by extractingthe juice andmixing with sugar(50:50), citricacid(1.5%), pectin(2%)and flavourings. Jelly hasalighterconsistencythanthesweetpotatojam.Sweetpotato (variety: Kamala Sundari) has been pickledinBangladesh using thetraditional ingredients.The sweetpotatopieceswereslightlyfried,toenhancethetaste. InIndia,thepalecreamvarieties ofsweetpotatoeswerefound togivethemostacceptable pickles**(Padmaja *et al.*,2012).**

Thedicedcubesarefirsttreatedwith1.0%acetic acidsolutionfor1htoprevent browningandimpartacid tastetotheslices.Thecubesarethenmadeintopickles using thestandardingredients.Theshelf lifeoftightlybottledpickleswasfoundtobemorethansixmonths **(Padmaja *et al.*,2012)**.

Thesofttextureofthesweetpotato pulpissuitedfor makingsoftdrinks, bymixingwith thick orthinfruitpulps/

juices.Thecooked/mashedandsievedpulpismixedwith ripemangopulpororange/lemon/pineapplejuiceandmadeintosoftdrinks.Appropriatefl avouringhasbeenfoundto enhancetheacceptability.**(Padmaja *et al.*,2012)**.

2.1.15 Futureperspectives

Althoughsweetpotatoisknownto bealowglycaemic food, thereisnotadequateresearch onthisaspectandonly afew products havebeendevelopedwiththisperspective.Never theless,consideringtheriseindiabeticandobesepopulationroundtheglobeandespeciall y intheAsiancountries, thereisanimminentneedtodeveloplowcalorieandlow glycaemicfoodslikepastaandnoodlesfrom sweetpotato. Browning relatedproblems insweetpotatoalsoneedsfurtherresearchasitadverselyaffectsproductdevelopment andtheconsumer appealoftheproducts. Thereisalackof utilization ofsweetpotatoforstarchextraction inmany countriesotherthanChinaandoneofthereasonscitedis thepresence oflatexwhichclogstheraspers andthepoor extractabilityofstarchfrom sweetpotatoes. Thisneedsfurtherresearchtoenhancestarchextraction throughenzymic methods,which facilitate thereleaseoftrappedstarch. Healthbenefits oforangeandpurple fleshed sweetpotato anditsleaveshavenotreceivedproperattentionfrom the researchersandconsumers,whichalso needsfurtherefforts **(Padmaja, *et al.*,2012)**.

2.1.16 Traditional uses

Sweetpotatoes are used in the treatment of tumors of the mouth and throat. Decoctions of the leaves can be used as an aphrodisiac, astringent, demulcent, laxative, energizer, bactericide and fungicidal agent.Sweetpotato has been found to be beneficial in treating asthma, bugbites, burns, catarrh, convalescence, diarrhea, fever, nausea, stomach distress, tumors, and whitlows (an infection of tip of finger). Therehave been anecdotal reports of the use of Ipomoea batatas in dengue, producing improvement in platelet counts. In region of Kagawa, Japan, a variety of white sweetpotato has been eaten raw to treat anemia, hypertension and diabetes **(Milind and Monika, 2015)**.

2.1.17Anti-diabetic activity

Despite its "sweet" name, it may be beneficial for diabetes according to some studies, since it helps in stabilizing blood sugar levels & lowers insulin resistance. The extract of white skinned sweetpotato called Caiapo reducesinsulin resistance, when administered inappropriate dose**(Milind and Monika, 2015**).

2.1.18 Miscellaneous uses

Tubers are used in starch and industrial alcohol production.In South America, the juice of red sweetpotatoes is combined with lime juice in varying proportions to make a dye for cloth (pink to black).All parts of the plant can be used for animal fodder.Sweetpotatoes are often found in ceramics. Several species of cultivatedin gardens as ornamental plants for their attractive foliage.George Washington Carver developed 118 products from sweet potatoes, including glue for postage stamps and starch for sizing cotton fabrics, and an alternative to corn syrup **(Milind and Monika, 2015)**.

2.2 Jam processing

2.2.1 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 a combination 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. These are pectin, sugar, and acid. The pectin forms the gel structure which makes the jam firmer rather than a runny pulp of juice. The sugar and acid are necessary to make the 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 fruit type and maturity. Unripe fruits have a lot of pectin which gives the fruit its firm and hard texture. As a fruit ripens, the pectin is broken down and so the fruit becomes 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)**.

2.2.2.2 Sugar

Sugar is present in all fruits but it is not enough to preserve the jam or jelly. In order 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 any excess water is evaporated to give the required sugar concentration **(Kordylas, 1990; Pradeep, 2013)**.

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 acids which differ in the different fruit varieties. Some fruits provide enough acid for a good jam, while, in others acid should be added from another source. The organic acids in fruits 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 with 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; Pradeep, 2013)**.

2.2.4 Jam processing methods

Jam can be commercially produced by using two methods. The first one is the open pan method which gives the product a traditional flavour with some carmelization of sugars. In the second commercial process, jam is produced under vacuum to reduce its boiling temperature to 65-80 $^{\circ}$C. The lower boiling temperature retaining more of the volatile flavouring compounds from the fruit, preventing sugar carmelization and of course reducing the over-all energy required to make the product. All the ingredients must be added in carefully measured amounts. 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 fruits arrive 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 into 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, a gentle water spray clears away the dirts at the fruit surface. Some fruits, such as citrus and apples may be manually peeled, cored, sliced and diced. Cherries 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 thickness and sweetness. Then, the flavourings 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 will be kept well for at least one year **(Kopjar and Sajple, 2009**).

2.3 Jam qualityand specifications

As reported by **SSMO (2006),** fruits that used in jam production shouldbe clean, uniform with high quality. Onlymaturefruits,withoutmould,excessive bruisingorinsectdamageshouldbeused.Alsostems,leaves,skinsshouldberemoved. Moreover, all jam ingredientsshould be accurately weighed. In addition to that, the pectinpowdershouldbethoroughlymixedwith some sugar and boiled water topreventlumpswhich lead to aweakgel 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. Also, as mentioned by **Onsa (2007),** 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 66.0% total soluble solids, 3.6 pH, 0.56 acidity, 62.6% total sugars, 22.9% reducing sugars, and 0.5 colour.

As stated bythe**Codex (2009),** the quantity of fruit pulp or fruit purée 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, rowanberries, seabuckthorns 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) 350grams 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.

CHAPTER THREE

3. MATERIALS AND METHODS

3.1 Materials

Sample of ripesweetpotato (*Ipomoea batatas* L.)Lam.) (Orange variety) was obtained from, Wdalgezoli inSinar State at the harvesting season (2016-2017).The sample was cleaned, tightlykept in polyethylene bags and stored at -18 °C until needed for the different investigations.

3.2 Methods

3.2.1 Chemical methods

3.2.1.1 Moisture content

The moisture content was determined according to the standard method of the Association of Official Analytical Chemists **(AOAC, 2010).**

Principle: The moisture content in a weighed sample is removed by heating the sample in an oven (under atmospheric pressure) at 105 °C. Then, the difference in weight before and after drying is calculated as a percentage from the initial weight.

Procedure: A sample of 10 gm ±1 mg was weighed into a pre-dried and tarred dish. Then, the sample was placed into an oven (No.03-822, FN 400, Turkey) at 105 ± 1 °C until a constant weight was obtained. After drying, the covered sample was transferred to desiccators and cooled to room temperature before reweighing. Triplicate results were obtained for each sample and the mean value was reported to two decimal points according to the following formula:

Calculation:

$$\text{Moisture content (\%)} = \frac{(W_s - W_d) \times 100\ \%}{\text{Sample weight (gm)}}$$

Where:

W_s = weight of sample before drying.

W_d = weight of sample after drying.

3.2.1.2 Crude protein content

The protein content was determined in all samples by micro-Kjeldahl method using a copper sulphate-sodium sulphate catalyst according to the official method of the **AOAC (2003).**

Principle: The method consists of sample oxidation and conversion of its nitrogen to ammonia, which reacts with the excess amount of sulphuric acid forming ammonium sulphate. After that, the solution was made alkaline and the ammonia was distilled into a standard solution of boric acid (2%) to form the ammonia-boric acid complex which is titrated against a standard solution of HC1 (0.1N). The protein content is calculated by multiplying the total N % by 6.25 as a conversion factor for protein.

Procedure: A sample of 10 grams was accurately weighed and transferred together with, 4g $NaSo_4$ of Kjeldahl catalysts (No. 0665, Scharlauchemie, Spain) and 25 m1 of concentrated sulphuric acid (No.0548111, HDWIC, India) into a Kjeldahl digestion flask. After that, the flask was placed into a Kjeldahl digestion unit (No.4071477, type KI 26, Gerhardt, Germany) for about 2 hours until a colourless digest was obtained and the flask was left to cool to room temperature.

The distillation of ammonia was carried out into 25m1 boric acid (2%) by using 20 ml sodium hydroxide solution (45%). Finally, the distillate was titrated with standard solution of HC1 (0.1N) in the presence of 2-3 drops of bromocreasol green and methyl red as an indicator until a brown reddish colour was observed.

Calculation:

$$\text{Crude Protein (\%)} = \frac{(\text{ml HCl sample} - \text{ml HCl blank}) \times N \times 14.00 \times F \times 100\%}{\text{Sample weight (gm)} \times 1000}$$

Where:

N: normality of HCl.

F: protein conversion factor = 6.25

3.2.1.3 Fat content

Fat content was determined according to the official method of the **AOAC (2003).**

Principle: The method determines the substances which-are soluble in petroleum ether (65-70 °C) and extractable under the specific conditions of Soxhlet extraction method. Then, the dried ether extract (fat content) is weighed and reported as a percentage based on the initial weight of the sample. **Procedure:** A sample of 5gm ± l mg was weighed into an extraction thimble and covered with cotton that previously extracted with hexane (No.9-16-24/25-29-51, LOBA Cheme, India). Then, the sample and a pre-dried and weighed extraction flask containing about 100 ml hexanes were attached to the extraction unit(Electrothermal, England) and the extraction process was conducted for 16 hrs. At the end of the extraction period, the flask was disconnected from the unit and the solvent was redistilled. Later, the flask with the remaining crude ether extract was put in an oven at 105 °C for 3 hrs , cooled to room temperature in a desiccators, reweighed and the dried extract was registered as fat content according to the following formula;

Calculation:

$$\text{Fat content (\%)} = \frac{(W_2 - W_1) \times 100\ \%}{W_3}$$

Where;

W_2 =Weight of the flask and ether extract

W_1 =Weight of the empty flask

W_3=initial weight of the sample

3.2.1.4 Total carbohydrates

Total carbohydrates were calculated by difference according to the following equation:

Total carbohydrates = 100% - (Moisture % + Protein % + Fat % + Ash %).

3.2.1.5 Available carbohydrates

Available carbohydrates were calculated by difference according to the following equation

Available carbohydrates = Total carbohydrates% – Crude fibre % .

3.2.1.6 Crude fiber content

The crude fiber was determined according to the official method of the **AOAC (2003).**

Principle: The crude fiber is determined gravimetrically after the sample is being chemically digested in chemical solutions. The weight of the residue after ignition is then corrected for ash content and is considered as a crude fiber.

Procedure: About 2gm ± 1 mg of a defatted sample was placed into a conical flask containing 200 m1 of H_2SO_4 (0.26 N). The flask was then, fitted to a condenser and allowed to boil for 30 minutes. At the end of the digestion period, the flask was removed and the digest was filtered (under vacuum) through a porclain filter crucible (No.3). After that, the precipitate was repeatedly rinsed with distilled boiled water followed by boiling in 200 ml NaOH (0.23 N) solution for 30 minutes under reflux condenser and the precipitate was filtered, rinsed with hot distilled water, 20m1 ethyl alcohol (96%) and 20 ml diethyl ether.

Finally, the crucible was dried at 105 °C (overnight) to a constant weight, cooled, weighed, ashed in a Muffle furnace (No.20. 301870, Carbolite, England) at 550-600 °C until a constant weight was obtained and the difference in weight was considered as crude fiber.

Calculation

$$\text{Crude fibre (\%)} = \frac{(W_1 - W_2) \times 100\%}{\text{(Sample weight (gm)}}$$

Where:

W_1 = weight of sample before ignition (gm).

W_2 = weight of sample after ignition (gm).

3.2.1.7Total, reducing and non-reducing sugars

The total sugars as well as reducing and non-reducing sugars were determined according to Lane and Eynon titrometric method as described by the Association of Official Analytical Chemists (**AOAC,2003)**.

Principle: Reducing sugars in pure solution in plant materials after suitable pre-treatment (to remove interference substances) may be estimated by using copper sulphate as oxidizing agent in a standard Fehling's solution.

Sample preparation

(A) Reducing sugars

A sample of 10 gm + 1 mg was weighted and transferred to 250 ml volumetric flask. 100 ml of distilled water was carefully added and then neutralized with 1.0 N NaOH to a pH 7.5 – 8.0. Then, about 2 ml of standard lead acetate (NO. 23500, BDH, England) was added and the flask was shaked and left to stand for 10 min. After that, 2 ml of sodium oxalate were added to remove the excess amount of lead acetate and the solution was made up to volume (250 ml) with distilled water and filtered.

(B) Total sugars

From the previous clear sample solution, 50 ml was pipetted into a 250 ml conical flask and 5 gm citric acid and 50 ml distilled water were added slowly.

Then, the mixture was gently boiled for 10 min to complete the inversion of sucrose and left to cool at room temperature. After that, the solution was transferred to 250 ml volumetric flask, neutralized with 20% NaOH solution in the presence of few drops of phenolphthalein (NO. 6606 J. T Baker, Holland) until the colour of the mixture disappeared and the sample was made up to volume before titration.

Procedure

A volume of 10 ml from the mixture of Fehling's (A) and (B) solutions was pipetted into 250 ml conical flask. Then, sufficient amount of the clarified sugars solution was added from burette to reduce Fehling's solution in the conical flask. After that, the solution was boiled until a faint blue colour is obtained. Then, few drops of methylene blue indicator (S-d-FINE-CHEM LIMITED) were added to Fehling's solution and titrated under boiling with sugars solution until brick-red colour of precipitate cuprous oxide was observed. Finally, the titer volume was recorded and the amount of inverted sugars was obtained from Lane and Eynon Table. The total sugars, reducing and non-reducing sugars were calculated by using the following formulas:

Calculation

$$\text{Total sugars } \{\% \text{ DM}\} = \frac{\{\text{invert sugar (mg) x dilution factor}\} \text{ x}100 \ \%}{\text{Titre x sample weight (g) x (100\% - moisture \%)} \times 1000}$$

$$\text{Reducing sugars } \{\% \text{ DM}\} = \frac{\{\text{invert sugar (mg) x dilution factor}\} \text{ x } 100 \ \%}{\text{Titre x sample weight (g) x (100\% - moisture \%) x } 1000}$$

Non-reducing sugars {% DM} = {Total sugars (%) – reducing sugars (%)}

Where: Titre = (Sample – blank)

3.2.1.8 Ash content

The ash content was determined according to the method described by the **AOAC (2010).**

Principle: The inorganic materials which are varying in concentration and composition are customary determined as a residue after being ignited at a specified heat degree.

Procedure: A sample of 5g ±1 mg was weighed into a pre-heated, cooled, weighed and tarred porcelain crucible and placed into a Muffle furnace (No.20. 301870, Carbolite, England) at 550 to 600 °C until a white gray ash was obtained. The crucible was transferred to a desiccator, allowed to cool to room temperature and weighed. After that, the ash content was calculated as a percentage based on the initial weight of the sample.

Calculation

$$\text{Ash (\%)} = \frac{[(\text{Wt of crucible} + \text{Ash}) - (\text{Wt of empty crucible})]}{\text{Initial weight (g)}} \times 100\ \%$$

3.2.1.9 Minerals content

Ten milliliters (10 ml) of HCL (2N) were added to the remaining ash sample and placed in a hot sand path for about 10-15 min. After that, the sample was diluted to 100 ml in a volumetric flask and filtered. The trace elements ferrous (Fe^{++})and Zinc (Zn) were determined according to **Perkin Elmer (1994)** by using Atomic Absorbance Spectroscopy (JENWAY 3110, UK). Sodium (Na) and potassium (K) were determined by using Flame Photometer (Model PEP7 JENWAY). While, calcium (Ca), magnesium (Mg), and phosphorus (P) were determined as described by **ChapmanandParratt (1961).**

3.2.1.10 Food energy value

The energy value of sweet potato jam product was calculated based on Atwater factors as indicated by **Leung (1968).**

Protein = 3.87 K. cal/g
Fat = 8.37 K. cal/g
Carbohydrate = 4.12 K. cal/g
K. cal = 4.184 kj

3.2.2 Physico-chemical methods

3.2.2.1 Total soluble solids

The total soluble solids as percent (T.S.S %) in the different samples were measured as described by **Ranganna (2001)**.

Principle: The index of refraction of a substance is a ratio of 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-Refractometer (No.002603, BS-eclipse, UK) with distilled water, the sample was placed on the surface of the refractometer prism, the prism was closed and the reading was recorded to the nearest 0.01 as T.S.S %.

3.2.2.2 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 solutions, the reading of the sample is recorded as pH value.

Procedure: After standardization of the pH-meter (N0.478530, Hanna, India) with buffer solutions (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 readings were expressed as pH to the nearest 0.01-pH units.

3.2.2.3Apparent viscosity

The apparent viscosity of the different samples was determined by using the method of **Quinn *etal.* (1975)**.Avolume of 100 ml distilled water was added to

20(g) sample into astainless steel cup with continuous stirring.Then,the sample slurry (20%w/v)was left for an equilibrium period of 5 min at room temperature.The apparent viscosity of the sample slurry was determined by using aBrookfield SynciroelectricViscometer (Model:Visco Basicplus R.S/n,VBCR 110393. Fungilab S.A,Spain)using spindle No. R2 at 100 rpm for one minute .The apparent viscosity was recorded in centipoises (cp)

Calculation:

Apparentviscosity (CP) = average viscometer reading ×[VF]

Where:

VF = Viscosity factor =100

3.2.3 Experimental jam processing method

After cleaning and washingsweetpotatoroots (5kg), the rootswere peeled, weighed (4 kg), and blanched in boiled water (1:3) for 15 min in a steel kettle. Afterthat, the blanched roots were blended by using electric blender. Then,the pH value and the total soluble solids (T.S.S %) of the blend were checked in order to calculate the required amounts of citric acid,pectin and sugar.

Sweetpotato juice (11.5kg) with the suitable amount of sugar (15kg) was placed in a steel kettle and the mixture was boiled quickly until the total soluble solids (T.S.S %) reached 64 °Brix. Immediately, citric acid (46gm) and pectin (210 gm) were added and mixed with continuous cooking until the T.S.S % of the mix reached 68 °Brix. Finally sweetpotato jam was filled hot in dried glass jars, tightly closed,lefttocool at room temperature and stored until needed for the chemical, physico-chemical and organoleptic evaluations. Sweetpotato jam recipe, processing method and conditions are shownin Table (1) and Fig (1), respectively.

3.2.4 Jam organoleptic evaluation method

Sweetpotato jam products were sensory evaluated as described by **Ranganna (2001).** In this method, 20 trained panelists from the Food Science and Technology Dept, College of Agricultural Studies, Sudan University of Science and Technology, were asked to evaluate the products with regard to their colour, flavour, taste, consistency and overall quality using the following quality scales:
1= excellent, 2= very good, 3= good, 4= acceptable, 5= unacceptable.

3.2.5 Statistical analysis method

The results were subjected to Statistical Analysis System (SAS) by using One-Factor Analysis of Variance (ANOVA). The Mean values were also tested and separated by using Duncan's Multiple Range Test (DMRT) as described by **Steel*et a1*. (1997).**

Table (1): Sweetpotato jam recipe

Ingredients	**Kg**	**(%)**
Sweetpotatoblend	11.50	42.98
Sugar	15.00	56.05
Pectin	00.21	00.80
Citric acid	00.046	00.17
Total weight	26.76	100.00

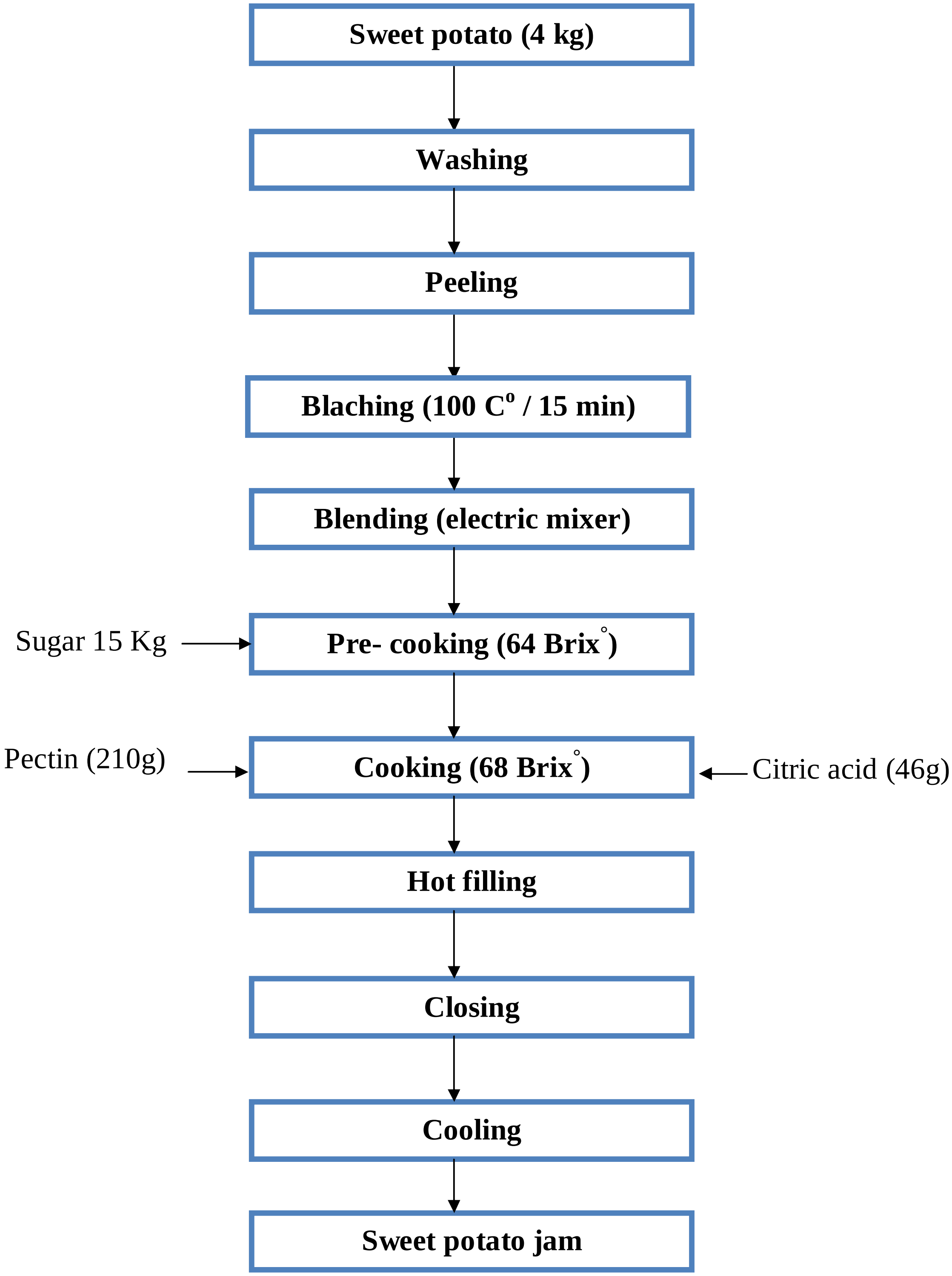

Fig. (1) Sweetpotato jam processing method

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Nutritional value of Sweetpotato roots

4.1.1 Chemical composition

Table (2) shows the chemical composition ofsweetpotatoroots pulp on wet and dry basis. Moisture, protein, fat, total carbohydrates, crude fiber, total sugars and ash were found to be 25.72%, 13.96 %,01.40%, 79.47 %,08.93%, 35.93%,05.17%,respectively on dry basis. Among the total sugars the reducing sugars, non-reducingsugars and ash constitute about 16.06 %,19.87%,05.17%,respectively.The results obtained in this study are in good agreementwith those reported by**Abdel-Rahman (2012)**,who found 12.22%, 01.28%,for the protein and fat respectivelyand disagree with the values of moisture, total carbohydrates,crude fiber, ash, which were 35.54%,60.14%, 14.30 %, 12.05%, respectively. This may be due to genotype of sweet potato.

4.1.2 Minerals content

Table (3) shows the minerals content ofsweet potatoroots pulp on wet and dry basis as mg/100g. From the results, the roots pulp was found to be very rich in calcium (322.28mg), potassium (281.26 mg), phosphorous (103.62mg), sodium (21.66 mg), iron (3.38 mg), magnesium (00.54 mg) and zinc (00.12 mg) on dry weight basis. In general, the results of this study are in disagreement with **Abdel-Rahman (2012)**, in genotype Zapalo who reported that calcium (29.24mg), potassium (207mg), phosphorous (26.13mg), sodium (14.95mg), iron (00.25mg), magnesium (9.15mg), and zinc (00.26mg) on dry basis, respectively.

Table (2): Chemical composition and energy value offresh sweet potato pulp

Chemical Composition	% On wet basis	% On dry basis
	(% ,n=3±SD)	
Moisture	74.28 ± 00.34	25.72 ± 00.33
Protein	03.59 ± 00.15	13.96 ± 0.750
Fat	00.36 ± 00.05	01.40 ± 00.17
Total Carbohydrates	20.44 ± 00.35	79.47 ± 01.64
Crude Fibre	02.30 ± 00.14	08.93 ± 00.47
Available Carbohydrates	18.14 ± 00.22	70.54 ± 00.93
Total sugars	09.2 4± 00.74	35.93 ± 02.56
Reducing sugars	04.13 ± 00.40	16.06 ± 01.36
Non-reducing sugars	05.11 ± 00.40	19.87 ± 00.25
Ash	01.33 ± 00.06	05.17 ± 00.20
Food energy value:		
K.Cal/100 g	91	355
K.J/100 g	381	1485

SD ≡ Standard deviation.

n ≡ Number of independent determinations.

Table (3): Minerals content of fresh sweet potato pulp

Minerals	**On wet basis**	**On dry basis**
	[mg / 100 gm, n = 3 ± SD]	
Sodium [Na]	05.57±00.67	21.66 ±02.62
Potassium [K]	72.34±03.59	281.26 ±14.01
Calcium [Ca]	82.89±02.38	322,28 ±13.59
Phoshorus [P]	26.65±01.83	103.62 ±06.72
Iron[Fe]	00.87±00.08	03.38±00.31
Magnesium[Mg]	00.14±00.01	00.54±00.04
Zinc[Zn]	00.03±0.00	00.12 ±00.01

n ≡ Number of independent determinations.

SD ≡ Standard deviation.

.

4.2 Suitability of sweet potato jam production

4.2.1Physical and physico-chemical characteristics of sweet potato blend

Table (4) shows thePhysical and physico-chemical characteristics of sweetpotato blend. From the results,the product was found to beweight of raw material is 4 kg, water weight 12 kg,weight of sweet potato blend11.50 kg,total soluble solids (T.S.S %) 7 %, hydrogen ions concentration (pH)5.71.

4.3 Quality evaluation ofsweet potatojam

4.3.1 Chemical and physico-chemical characteristics

The chemical and physic-chemical characteristics of sweetpotato jam are indicated in Table (5).From the results, the product was found to be total soluble solids (71), hydrogen ion concentration 03.01± 1.06and viscosity 1806. These results agree to those reported by the **SSMO(2006);Onsa (2007)** and **Javanmard (2010).**

4.3.2 Nutritional value

4.3.2.1 Chemical composition and energy value

The chemical composition and energy value ofsweetpotato jam are shown in Table (6). From the results,the product was found to be with high level of totalsugars (55.92%), non-reducing sugars (44.53%) andreducing sugars (11.39%)but, with low level of protein (05.38%),ash (01.34%) and fat (00.36%),on wet basis.Therefore,provide an adequate energy value (254.22 k.cal/100g).The results obtained in this study are in disagreement with **Elsayaid (2008)**.

Table (4): Physical and physico-chemical characteristics of sweet potato blend

Parameter	**Sweetpotato blend**
Total soluble solids (T.S.S %)	07 %
Hydrogen ions concentration (pH)	05.71

Table (5): Physico-chemical properties of sweet potato jam

Chemical composition	**On wet basis** [n = 3 ± SD]
Total soluble solids (T.S.S %)	71
Hydrogen Ion concentration(pH)	0 3.01± 1.06
Viscosity (CP)	1806

Table (6): Chemical composition and energy value of sweet potatojam

Chemical Composition	% On wet basis (%,n = 3± SD)
Protein	05.38±00.09
Fat	00.36±00.05
Total sugars	55.92±00.16
Reducing sugars	11.39±00.90
Non-reducing sugars	44.53±00.07
Ash	01.34±00.13
Food energy value:	
K.Cal /100 g	254.22±02.69
K.J /100 g	1063.66±11.29

SD ≡ Standard deviation.

n ≡ Number of independent determinations.

4.3.2.2 Minerals content

Table (7) gives the minerals concentration in sweetpotato jam as mg/100g on wet basis. The product was found to provide appreciable amounts ofcalcium (97.66mg), potassium (65.62mg), phosphorus(34.02mg), sodium (06.7mg),iron (01.07mg),zinc (00.67mg),magnesium (00.32mg).

4.3.3 Organoleptic evaluation

The organoleptic evaluation of sweetpotato jam was carried out by using trained panelists from the Food Science and Technology Dept., College of Agricultural Studies, Sudan University of Science and Technology.

The results in Table (7) show the recorded scores by the panelists for the differentsweetpotato jam samples with respect to their colour, taste, flavour, consistency and overall acceptability.In general, bothsweetpotato jam that produced with or without flavour were highly accepted by the panelists.The result of organoleptic evaluation indicated that there was no significantdifferences inconsistency and overall qualitybetween the two products.However, there was significant differences with respect to their colour, taste andflavour. The high taste and flavour score obtained by sample B (sweetpotato jam that produced with pineapple flavour) which was highly preferred by the panelists in comparison with that produced without any flavour.

Table (7): Minerals content of sweet potato jam

Minerals	**On wet basis**
	[mg / 100 gm, n]
Sodium [Na]	06.7 ± 00.19
Potassium[K]	65.62 ± 33.13
Calcium [Ca]	97.66 ± 01.77
Phoshorus[P]	34.02 ± 04.39
Iron[Fe]	01.07 ± 00.00
Magnesium[Mg]	00.32 ± 00.09
Zinc[Zn]	00.67 ± 00.18

n ≡ Number of independent determinations.

SD ≡ Standard deviation.

Table (8): Organoleptic evaluation of sweet potato jam product

Samples	**Colour**	**Taste**	**Flavour**	**Consistency**	**Overall quality**
	Score (n =20 ± SD)				
A	$1.35^{b}\pm 0.59$	$1.75^{a}\pm 0.64$	$2.00^{a}\pm 0.65$	$1.95^{a}\pm 0.83$	$1.70^{a}\pm 0.66$
B	$1.70^{a}\pm 0.73$	$1.45^{b}\pm 0.76$	$1.55^{b}\pm 0.76$	$2.05^{a}\pm 1.05$	$1.95^{a}\pm 0.94$
$Lsd_{0.05}$	0.348^{*}	0.297^{*}	0.421^{*}	0.137^{NS}	0.269^{NS}
SE±	0.116	0.099	0.143	0.046	0.089

Values are mean±SD.

Means having different superscripts in each column are significantly different ($P\leq 0.05$).

n = number of independent determination.

SD = Standard deviation.

Key:

A ≡ Sweet potato jam without flavour

B ≡ Sweet potato jam with pineapple flavour

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1Conclusion

According to the finding of this study, itis possible to manufacture sweetpotatojam with high quality and does not need to use artificial colour, andtherefore we can reduce the hazard of food additives.Addition ofpineapple flavour (natural) as leads to excellent product.

5.2 Recommendations

1. Awareness of people to nutritional value, economical importance of orange fleshed sweetpotato is recommended.
2. The industrial utilization of sweetpotato roots in jam production in Sudan should be encouraged.
3. sweet potato jam is recommended for children.
4. Encourage thecultivation of big area of orange fleshed sweetpotato.
5. Further research is needed in production of jam from sweetpotato crops.

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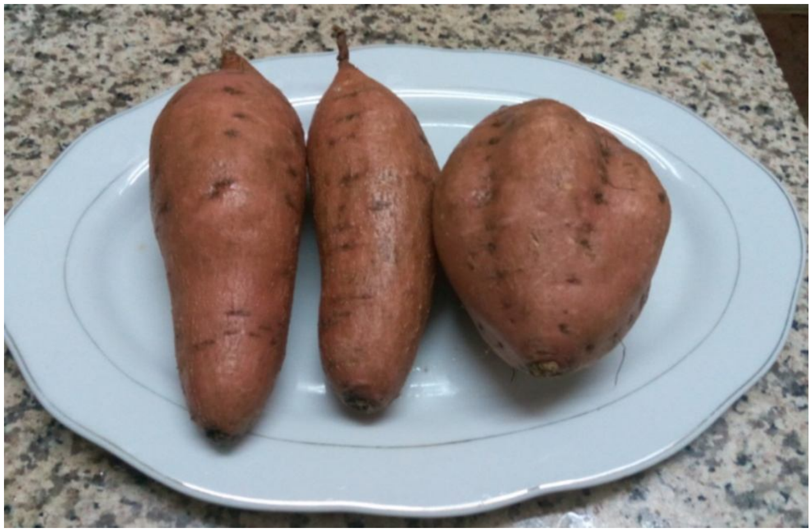
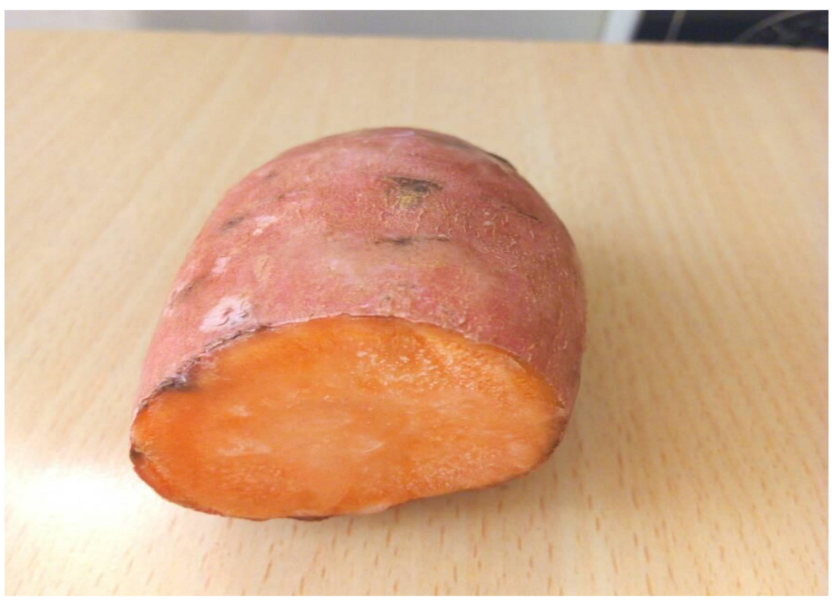
APPENDICES

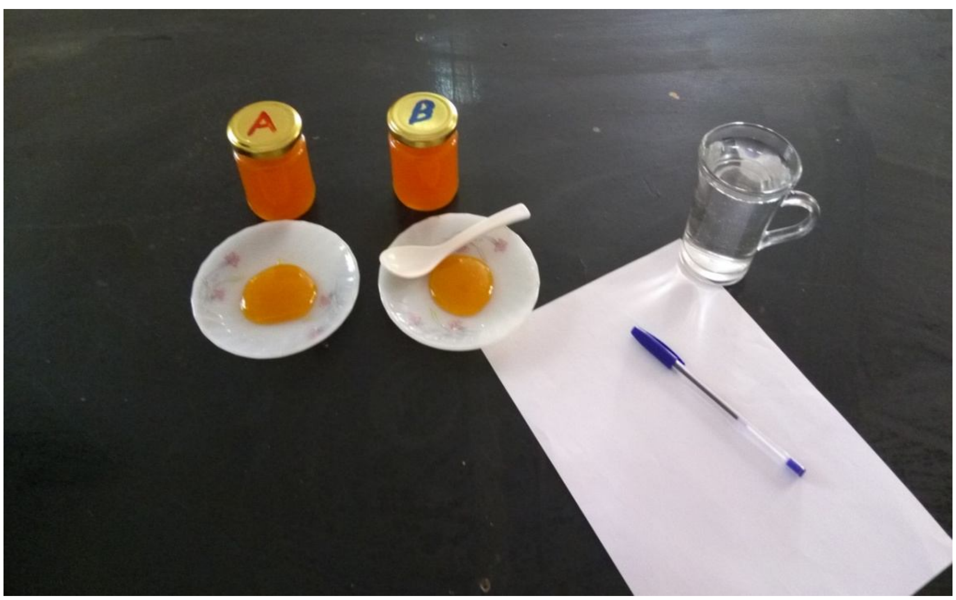


Appendix1: Sweetpotato root



Appendix2:Venial Section for sweetpotato root

Appendix3:Sweetpotato jam



Appendix4:Sensory evaluation of sweetpotato jam