QUALITY EVALUATION OF GREEN BANANA (cv. Nendran) IN DIFFERENT STAGES OF MATURITY

Aims: Banana(Musaspp.) isagloballysignificanttropicalfruitcrop,valuedforitseconomicimportance and asa staple food thatcontributessignificantlyto human nutrition.The Nendran banana variety(Musa AAB)iswidelycultivatedintheSouthIndianstates ofTamilNadu,Kerala, andKarnataka, andisalsowell- known in otherregionsworldwide.Thisstudyaimstoexamine the physical,chemical,and nutritional characteristicsofNendranbananasatvariousmaturitystages—75,80,85,and90daysafter flower emergence.

Studydesign: Completelyrandomizeddesign (CRD).

PlaceandDurationofStudy: Departmentofcommunity science,CollegeofAgriculture,Vellayani,Kerala Agricultural University, betweenFebruary2024toOctober2024

Methodology: Nendranbananasforthisstudywereobtainedfrom alocalfarmer in Vellayani, Thiruvananthapuram.Maturitywasmonitoredbytaggingthe plantson thedayofflower emergence,and thefruitswereharvestedatintervalsof75,80,85,and90dayspost-emergence.Ateachstage,greenfruits wereselectedfromthemiddlethreefruitsofthethirdhandfromthetopofeachbunchandtakenforphysical (fruit weight,fruitlength,circumference,peel weight,pulpweight),chemical(moisture,acidity,TSS,crude fiberandtannin)andnutritional(starch,protein,total sugar,reducingsugar)analysis.

Results: Theresultindicate thattheripening processsignificantlyimpactsthephysical,chemical,and nutritionalpropertiesofNendranbananas.Physical attributessuchasfruitweight,pulpweight, fruitlength, and diameterreached their maximum at90 days,whilepeelweightwashighestat75 days.Chemical analysisdemonstrated thatmoisturecontent, acidity,and totalsolublesolids(TSS) weregreatestat90 days,whereascrudefiberandtannincontentpeakedat75days.Nutritional analysis revealed that protein, totalsugar,andreducingsugarlevelswerehighestat90days,whilestarchcontentwashighestat75days. These findingshighlighthowunderstanding the nutritionalprofileof unripe greenNendran bananasat differentmaturitystagesoffersvaluableinsightsintothechemicaltransformationsthatoccur throughout theripeningprocess.

Keywords:Nendran,Maturity,Greenbanana,Nutrients ,Physico-chemical,

1.INTRODUCTION

Banana(Musa spp.)is amajor tropical fruit cropglobally, holding substantial economicimportanceand servingasa staple foodwithavitalroleinhumannutrition(Auroreetal.,2009).Indiaistheworld'stopbananagrower,withChina,Ecuador, Brazil, and thePhilippines following closelyafter(Nayar,2010). Bananas arenutritious, sweet,andreadily digestablefruits highincarbohydratesandmineralssuchaspotassium,magnesium,salt,andphosphorus.Theyevenhavemorecalories thanpotatoes(PereiraandMaraschin,2015).Bananasarespecialinthattheymixenergy-givingingredientswithtissue-buildingnutrientsincludingprotein,vitamins,andminerals(QamarandShaikh,2018).Theycancontributesignificantlyto the vitaminA,C, andB6levelsin thedietwhilealsoprovidinganinstantsourceof energy(Singhetal., 2016).

TherawbananavarietyMusa (AAB)cv.Nendranis extensivelycultivatedintheSouthIndianstates ofTamilNadu,Kerala, andKarnataka,andisalsopopularinotherregionsworldwide.Keralanowgenerateslessthan30%ofitsbanana requirementsandreliesonTamilNadutoassistcoverthegap(Hassan,2016).The stateis hometoawideassortmentof bananacultivars, eachhavingitsownregional preferences andeconomicworth.Among them,theNendran varietyisvery popularinKeralaandiswidelyplantedforbothfreshfruitconsumptionandbananachipproduction.Itisenjoyedinboth unripeandripestages.NendranbelongstotheFrenchplantain familyandisanimportantpartofthelocaldiet.However, theareaallocatedtobananaproductioninKeralaisshrinkingasfarmersturntomoreprofitablecrops.Nonetheless, bananas'profoundhistorical,economic,andevenreligioussignificanceinKeralahelpstokeepthecropfrombeingfully eclipsedby otheragriculturalendeavours(Siji andNandini, 2017).

Nendranbananasmature5-6monthsafterblossoming,producinglarge,thickfruitswithahighshelflife.UnripeNendran isidealforKeralabananachipsandisoftenusedasafirstweaningsnackforinfantsinIndia(Chitra,2015).Thefruits average20-27cminlength,14-18cmindiameter,andhaveathickpeelwiththreeridgesandauniquetip.ANendran bunchweighs12-15kg,consistingof4-6handswith8-10fingerseach.Thecreamypale-yellowfleshofunripefruits deepenstoyellowish-orangeastheyripen,whilethepeeltransitionsfromgreentoyellowandlaterdevelopsdarkspots (Sreejith andSabu, 2017).Unripe fleshhas abland,starchy texture,whichbecomes sweetand creamy as starchconverts tosugar(Sumanetal., 2018).Nendranflowerbracts arerichinanthocyaninswithanticancerproperties,its peel contains ametalloproteasewithcollagenolyticandcytotoxiceffects,anditsfructansactasprebioticsbypromotinglacticacidbacteria (Shalini et al.,2017).

2.MATERIAL AND METHODS

2.1Collection ofRawMaterials

Inthisstudy,Nendranbananasweresourcedfromalocalfarmeratvellayani,thiruvananathapuram.Toaccurately determinematurity, thebananasweretaggedonthedayofflroweremergence.Fruits wereharvestedat75,80, 85,and90 dayspost-emergence.Foreachmaturitystage,greenfruitswerecollectedfromthemiddlethreefruitsonthethirdhand from the topofeachbunchandbroughtto thelaboratory for subsequent physicalandbiochemicalanalyses.

2.2Physical Parameters

Thephysicalparameters of unripegreenbanana fruits wereassessedusing themethoddescribedby DadzieandOrchard (1997).
Thelengthofeachfruitwasmeasuredalongitsoutercurvefromthedistalendusingameasuringtape.Measurements weretakenfromaminimumoffivefruits.Thecircumferenceofeachfruitwasmeasuredatitswidestmidpointusinga measuringtape,ensuringconsistencyinthemeasurementprocess.Readingswerecollectedfromthreefruitsateach maturitystagetoprovidearepresentativeassessmentoffruitcircumferenceacrossdifferentdevelopmentalphases.In addition,theweightoftheunripegreenfruits,aswellastheindividualweightsofthepulpandpeel,wereaccurately determinedusinganelectronicbalance.Thismethodallowedforprecisequantificationofthevariouscomponentsofthe fruit, facilitatingdetailedanalysis oftheirphysical characteristics.

2.3Chemicalparameters

For theanalysis ofchemical parameters,thefruit pulpwascutinto uniformpiecesandimmersedinapretreatmentsolution (Karthikeyan,2015)to minimizebrowningreactions.Subsequently,thetreatedpulpwas groundintoafinepasteforfurther analysis.

2.3.1MoistureContent

Moisturecontentwas determinedaccording totheAOAC(2010).

2.3.2TitratableAcidity

Titratableaciditywasmeasured accordingto themethod established byRanganna,(1977).Aknown volume ofthe fruit samplewastaken and titrated with a 0.1 Nsodium hydroxide (NaOH) solution,using phenolphthaleinasan indicator.The acidity levelswerereportedas apercentage(%).

2.3.3TotalSolubleSugars

Totalsolublesolids(TSS) were measured using a hand refractometer with a range of0 to 32 °Brixand were expressed in degrees Brix(°Brix)according tothemethoddescribedby Ranganna(1977).

2.3.4CrudeFiber

Crudefibercontentwasdeterminedusingtheacid-alkalidigestionmethodasrecommendedbyChopraandKanwar(1978).

2.4Nutritional Parameters

2.4.1StarchContent

Starch contentwasdeterminedusingtheacidhydrolysis method.

2.4.2Protein

Theprotein contentin banana samples was determinedusing themicroKjeldahl wet digestionmethod(AOAC,2000).

2.4.3TotalSugar

Totalsugarsinthe samplewere estimatedfollowing theAOAC(1980)method andexpressed asa percentage ona fresh weight basis.

2.4.4ReducingSugar

ReducingsugarsweredeterminedbythecopperreductionmethodusingFehling'ssolution(AOAC,1980)andexpressed as apercentage.

3.RESULTSAND DISCUSSION

Significantchangeswere observedinthe physical,chemical,andnutritionalparametersofbananasatdifferentmaturity stages. Thevariationin theseparametershighlights howmaturationimpacts thefruit'scomposition,includingaspectssuch astexture,sugarcontent,acidity,andnutrientlevels.Thisunderscorestheimportanceofmaturityindeterminingthequality andnutritionalprofileofbananas,influencingboththeirconsumeracceptabilityandpotentialapplicationsinfoodprocessing andnutrition.

3.1PhysicalParameters

Thephysicalcharacteristicsofbanana fingersshowedsignificantvariationsacrossthe differentmaturitystagestested (Table1).Fruit weightwasnotablyaffectedbythestageofmaturity,withthe90-daymaturity stage(149.25) exhibiting the highestfruitweight,whilethe75-daystage recordedthelowestamongthosetested.Intermsof peelandpulpweight,the 75-daymaturitystagehadahigherpeelweightbutalowerpulp weight.Conversely,the90-day maturitystageshowedan increasedpulpweight,highlightingtheshiftinfruitcompositionwithadvancingmaturity.Fruitlengthwasalsoinfluencedby maturity stage,with the90-daymaturity showing thegreatest lengthcompared to theother stages. The75-day and80-day maturitystages exhibitedsimilarfruitlengths, indicatingminimal variationbetweenthem.Intermsoffruit diameter,the90-daymaturitystagerecordedthehighestdiameter,whiletheother maturitystagesshowedsimilar measurements. ComparablechangeshavebeendocumentedbyRodriquez-Sosaetal.(1977)intheirresearchonbananaflourpreparation.

Table 1

Physical parametersof bananafingers

Maturity (Days)	Fruit weight (g)	Peel weight (g)	Pulp weight (g)	Fruit length (cm)	Fruit diameter (cm)

75	115.25^{b}	50.75^{a}	56.50^{c}	18.175^{b}	11.175^{b}
80	109.50^{b}	39.50^{bc}	66.25^{b}	18.350^{b}	11.350^{b}
85	116.50^{b}	39.0^{c}	75.50^{ab}	21.05^{ab}	11.625^{ab}
90	149.25^{a}	48.0^{ab}	81.25^{a}	22.325^{a}	12.275^{a}
SE(d)	8.215	3.999	4.26	1.351	0.316
SE(m)	5.809	2.828	3.012	0.955	0.223
LSD	17.898	8.712	9.281	2.943	0.688

3.2ChemicalCompositionofBanana

The chemicalcompositionof greenNendranbananaswere evaluated, showing significantdifferencesacrossvarious maturitystages(Table 2). Thisanalysishighlights theunique chemicalcomposition at each stage, demonstrating the progression ofchangesasthe fruitmatures.These findingsunderscore the importance ofunderstanding such differences forapplications innutritional profilingandpost-harvestmanagement.

Themoisturecontentinbananasisobservedto behighestat90daysofmaturity(59.410%)andlowestat75days (49.603%).Typically,asbananasundergo theripening process,their moisture contentrangesfrom 60%to 68.6%,and progressivelyincreasestolevelsbetween68.6%and78.1%(Sakyietal.,2008). Thisincreaseinmoisturecontent during ripeningislikelyattributed tothe breakdownofcarbohydrates,whichleadstothesofteningoftissuetexture,aswellas osmotic transfer from thepeel to thepulp (Onwuka,G.I.and Onwuka,N.D. 2005).

Theacidityofbanana fingershasbeen analyzed,and findingsindicatethatthe highestaciditylevelsareobserved at90 daysofmaturitycompared to other stages.Thissuggeststhatasbananasprogressthrough their ripening process,the acidityinitiallyincreasesand peaksatthe later stage of90 days.High acidityatthispointisoften associatedwith the biochemicalchangesthatoccur asthe fruitripens,including the conversionofstarchesinto sugarsand the formation of organicacids(wyman,1964).Thesechangescontributeto theflavorprofileofthebanana,enhancingitsoveralltasteand sensory characteristics, SreedeviandSuma(2015)reported similarresults,as did Mayadevi(2016).

Intheanalysis oftotal solublesugarsacrossdifferentmaturity,itwasobservedthattheconcentrationwashighestatday 90 (14.200^{0}brix)and lowestatday75(4.800^{0}brix).Thistrend indicatesa significantincrease insolublesugar contentas the maturityofthe sample advances.The increase intotalsolublesugarsduring ripening isan essentialtraitthatreflects the hydrolysisofstarch into solublesugars,including glucose,sucrose,and fructose(Meghwaletal.,2021).Thisprocess underscoresthe enzymaticconversion thatoccursasthe fruitmatures,contributing to the accumulationofsugarsand enhancing the sweetness andoverallquality oftheproduce(Tirkeyet al., 2003).The significantrisein total solublesugars atadvanced maturity,suchasday 90, highlightstheculminationofstarchbreakdownandsugarsynthesis.Conversely,the lower sugar contentatday75 indicatesan earlier stageofdevelopmentwhere thisconversion islesspronounced.These observationsarecrucialforoptimizingharvesttimingtoachievethedesiredsugarprofileinagriculturalandfoodproduction practices (Mahato etal., 2014).

Crudefibercontentwasfound to be highestattheearlier stageof75daysanddecreased significantlyby90days.This trendwassimilarlyobservedin unripebananas,wherethecrudefibercompositionwasinitiallyhighbutdeclinedasthefruit ripened(DhavalandNaik,2010).BarnellHR(1940)notedinhisworkthatthedecreaseincrudefiberduringripeningisdue totheenzymatic breakdownofcomplex polysaccharides intosimpler,moreeasilydigestible forms. Thistransformation, as the fruitripensfrom an unripetoafullymature state,involvesthedegradationofcellwallcomponentslike cellulose and hemicellulose,leading toasoftertextureandimprovedpalatability. Understandingthispatternis importantfordetermining optimalharvesttimes,particularlyforapplicationswherefiber contentplaysaroleinthenutritionalorfunctionalqualityof theproduce.

In the presentstudy,tannin contentwasfound to behighestatday75 and decreased significantlybyday90.Thisfinding alignswithpreviousresearchbyKhawasetal.(2014),whichdemonstratedthatthetannincontentinbananasamplesvaries significantlyacrossdifferentstagesofdevelopment.Thedeclineintanninlevelsduringmaturationcontributestothesensory evolutionofthefruit. As notedbySzajdek andBorowska(2008),tannins playa crucial role inshaping these nsorypropertiesoffruitsandfruitproducts,impartingacharacteristictartnessandinfluencingcolorchangesinboththe fruit andits derivedjuices.Thereductionintannin contentatadvancedripening stagescorresponds tothe softeningof the fruit and a shifttowardsa sweeter taste profile,enhancing consumer appealand usabilityinvariousculinaryand processing contexts.

Table 2						
Chemical parametersofbananafingers						
Sl.no	Maturity (Days)	Moisture (%)	Acidity (%)	TSS (^{0}brix)	Crude fiber (%)	Tannin (g100g^{-1})
1	75	49.603^{d}	0.133^{d}	4.800^{d}	4.043^{a}	8.017^{a}
2	80	53.457^{c}	0.160^{c}	7.013^{c}	3.337^{b}	7.347^{b}
3	85	55.813^{b}	0.190^{b}	10.900^{b}	3.290^{c}	6.770^{c}
4	90	59.410^{a}	0.233^{a}	14.200^{a}	2.850^{d}	5.897^{d}
	SE(d)	0.026	0.008	0.002	0.008	0.009
	SE(m)	0.018	0.006	0.002	0.006	0.006
	LSD	0.06	0.018	0.005	0.018	0.021

3.2NutritionalParameters

ThenutritionalpropertiesofgreenNendranbananaswere investigated,with an emphasisonstarch,protein,totalsugar, andreducing sugars.Theresearchprovidesa fullunderstandingof thenutritionalcompositionofbananasatvarious developmentstages.Starch,beingthemajorcarbohydrateinunripebananas,contributessignificantlytotheoverallenergy contentand steadilydiminishesasthe fruitripensand convertsinto simpler sugars. Proteinlevelsadd to the nutritional value,butin lesserproportionsthan carbs.Totalsugarand reducingsugars,whicharecriticalforflavourandpalatability, werealsomeasured, demonstratinghowthese components risewithstarchhydrolysis throughoutripening.Understanding thesenutritionalprofilesiscriticalformakingthebestuseofgreenNendranbananasindietaryplanningandfoodprocessing applications.

In the currentstudy,the starch contentofunripe bananaswasshown to fluctuate from84%atday75 to 76.4%atday90. Starch levelspeakedatday75anddroppedasthefruitgrewtoday90. According toButaniand Chovatia(2014),the breakdownofstarchinto simpler sugarsduringtheripeningprocessresultsinthesweeter tasteandsoftertexture characteristic ofripebananas.

In the investigation ofgreen Nendran bananas,theprotein contentwasshown to begreateratday90 whencompared to othermaturitystages.Thisincrease inproteincontentasthe fruitmaturesmaybedue to biochemicalchangesthatoccur duringripening,such asthe creation and accumulation ofnumerousenzymesand structuralproteins. Whileproteinsare notthe predominantnutritionalcomponentofbananas,their contribution isconsiderablewhen considering the fruit'stotal nutritionalprofile.Theriseatday90suggeststhatfullyripenedbananasmayhavemoreproteincontent, addingto their nutritionalworth(Vanilarasu and Balakrishnamurthy,2014).Thisinformation,togetherwith data on starchconversion and sugarbuildup,helps tohighlighttheoverallnutritional advantagesof bananasat differentstagesofmaturity(Lohi2010).

The totalsugarsinunripebananapulpwereanalysed atvariousdevelopmentstages.The investigation revealedthatthe overallsugarlevel was greatest atday 90when compared to theother stages. These findings alignwithprevious research byLodhetal.(1973),whichfoundcomparablepatternsoftotalsugar concentrationinbananasatvariousstagesof maturation.

Venkatarayappaet al. (1976)andChellappan(1983)reportedthat dessertbananas contained significantly higherlevelsof reducingsugars,whereascooking bananasandplantainsexhibitedgreaternon-reducing sugar content.Thisstudyfound thatreducingsugarlevelswerehighest atthe90maturityday compared toearlierstages.

Table 3					
NutritionalParametersofBananaFingers					
Sl. no	Maturity (Days)	Starch (mg)	Protein (mg)	Total sugars (%)	Reducing sugars (%)

1	75	84.0^{a}	1.50^{d}	1.83^{d}	0.250^{d}
2	80	83.5^{b}	1.90^{c}	2.10^{c}	0.450^{c}
3	85	80.1^{c}	2.20^{b}	2.610^{b}	0.806^{b}
4	90	76.4^{d}	2.31^{a}	2.806^{a}	1.033^{a}
	SE(d)	0.071	0	0.025	0.024
	SE(m)	0.05	0	0.018	0.017
	LSD	0.163	0	0.058	0.055

4.CONCLUSION

Thisstudyrevealshowthenutritionalmakeupofbananas varieswithdevelopmentstage.Thedatashowsthatripeninghas a substantial influenceonthephysical, chemical,andnutritional aspectsofNendranbananas.Physical measuressuchas fruitweight,pulpweight,fruitlength,andfruitdiameterwerehigheratday90,butpeelweightwashighestatday75. Chemicalanalysisrevealedthatmoisturecontent,acidity,andtotal soluble solids(TSS)peakedatday90,whereas crude fibreandtanninlevelspeakedatday75.Intermsofnutritionalcharacteristics,protein,totalsugar,andreducingsugar concentrationswerehighestatday90,whereasstarchcontentwashighestatday75.Thefindingsshowedthatknowing thenutritionalqualityofunripenedgreenNendranbananasatvariousmaturitystagesprovidesinsightsintothechemical changesthatoccurduringripening.Thisknowledgecanbeusedtoextendtheusageofbananasinavarietyofculinary items. Theoutcomes ofthisstudywillhelpthefoodsectoroptimisenutritionalcontentswhendevelopingnewproductsthat incorporatetheexaminedbanana cultivar.

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5.REFERENCE

AOAC.(1980).AssociationofOfficialAnalyticalChemists,OfficialMethodsofAnalysisoftheAssociationof Official Analytical Chemists (14thed.).AOACInternational, WashingtonDC.

AOAC.(2000).AssociationofOfficialAnalyticalChemistsOfficialMethodsofAnalysisoftheAssociationof Official Analytical Chemists (17thed.).AOACInternational, WashingtonDC.

AOAC.(2010).AssociationofOfficialAnalyticalChemistsOfficialMethodsofAnalysisoftheAssociationof Official Analytical Chemists (18thed.).AOACInternational, WashingtonDC.

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Aurore,G.,Parfait,B.,&Fahrasmane,L.(2009).Bananas,rawmaterialsformakingprocessedfoodproducts.Trendsin FoodSciTechnol,20(2),78–91.doi:10.1016/j.tifs.2008.10.003.

Barnell,H.R. (1940).Studies intropical fruits. VII.Carbohydratemetabolismofthebanana fruit.AnnBot,7(4),297-309.

Butani,A.M.,&Chovatia,R.S.(2014).Effectofchemicalfertilizerandvermicompostondaystoflowering,harvestingand maturityof banana(MusaparadisiacaL.)cv. GrandNaine.TheAsian Journal Horticulture, 9(2),305−308.

Chellappan,K.(1983).Effect of 2,4-DandGAonfruitdevelopmentandpostharvest physiologyin bananas.Ph.D.Thesis, Faculty ofHorticulture,TamilNaduAgricultural University,Coimbatore,TamilNadu, India.

Chitra,P.(2015).Development ofbanana-basedweaningfoodmixesforinfantsanditsnutritionalqualityevaluation.Rev EnvironHealth,30(2), 125-130.doi:10.1515/reveh-2015-0002

Chopra,S.L.,& Kanwar,J.S.(1978).Analytical Agricultural Chemistry, Kalyani Publishers: Ludhiana.

Dadzie,B.K.,&Orchard,J.E.(1997).Routinepost-harvestscreeningofbanana/plantainhybrids:criteriaandmethods(Vol. 2).Bioversity International.

Dhaval.R.P.,&Naik,A.G.(2010).Effectofpre-harvesttreatmentoforganicmanuresandinorganicfertilizersonpostharvest shelf life ofsapotacv. Kalipatti. IndianJHortic, 67(3), 381−386.

Hassan,S.N.(2016).AStudyonTechnologicalGapinBananaCultivationTechnologiesinSouthernDistrictofTamil Nadu.International JournalofScientificandResearchPublication,*6*(7),pp.388-394.

Karthikeyan,N.(2015).Developmentofvalueaddedproducts frombananapeel.M.Sc.(FS&N)thesis,KeralaAgricultural University,Thrissur.

Khawas,P.,Das,A.J.,Dash,K.K.,&Deka,S.C.(2014)Thin-LayerDryingCharacteristicsofKachkalBananaPeel(Musa ABB)ofAssam,India.IntFoodResJ, 21,975-982.

Lodh, S. B., Divakar,N.G., Chadha, K.L., Melanta, K.R., &Selvaraj, Y.(1973). Biochemicalchangesassociated with growthanddevelopmentofpineapplefruitvarietyKew.III.Changesinplantpigmentsandenzymeactivity.IndianJ Hortic,*30*,381-383.

Lohi,D.J.(2010). Medicinalandnutritionalvaluesofbananacv.Nendran. Asian JournalofHorticulture,5(1):11-14.

Mahato,S.K.,Suresh,C.P.,&Kuna,R.K.(2014).Effectsofinorganicfertilizationongrowth,yieldandfruitqualityofplantain cv. Nendran.PlantArch14(2),939−944.

Mayadevi,M.R. (2016).Efficiency of.vermi conversionanddecompositionoffarmresidues on soilhealth,yield andquality of banana(Musaspp.)Ph.D.Thesis,Kerala AgriculturalUniversity, 150−198.

Meghwal,M.L.,Jyothi,M.L.,Pushpalatha,P.B.,&Bhaskar,J.(2021).YieldandfruitqualityofbananaMusa(AAB) Nendranas influencedby nutrientsources.International JournalofBio-resourceandStressManagement, 12(2),131-136.

Nayar, N. M. (2010). The bananas: Botany, origin, dispersal. In Horticultural reviews. John Wiley &Sons, Inc. doi:10.1002/9780470527238.ch2.

Onwuka, G.I.,&Onwuka,N.D. (2005).TheEffects ofRipeningon theFunctional Properties ofPlantain andPlantainBased Cake.IntJFoodProp,8(2), 347-353.https://doi.org/10.1081/JFP-200059489
Pereira,A.,&Maraschin,M.(2015).Banana(Musaspp)frompeeltopulp:Ethnopharmacology,sourceofbioactive compounds andits relevanceforhumanhealth.J Ethnopharmacol, 160, 149–163. doi:10.1016/j.jep.2014.11.008.

Qamar,S.,&Shaikh,A.(2018).Therapeutic potentialsandcompositional changesofvaluablecompoundsfrombanana-A review.TrendsFoodSciTechnol, 79,1–9.doi:10.1016/j.tifs.2018.06.016.

Ranganna,S.,(1977).ManualforAnalysisofFruitandVegetableProducts.TataMcGraw-HillPublicationCompanyLtd, NewDelhi, India.

Rodriguez-Sosa,E.J.,GONZÁLEZ,M.,CALONI,I.,&Parsi-Ros,O.(1977).Thepreparationofgreenbananaflour.Journal ofAgricultureoftheUniversity ofPuertoRico,*61*(4), 470-478.

Sakyi-Dawson,E.,Asamoah-Bonti,P.,&Annor,G.A.(2008)Biochemical ChangesinNewPlantainandCookingBanana Hybrids atVarious StagesofRipening.J SciFoodAgric,88(15), 2724-2729. https://doi.org/10.1002/jsfa.3399.

Shalini, R.,Abinaya, G., Saranya,P.,& Antony, U.(2017). Growthofselectedprobioticbacterial strainswithfructans from Nendranbananaandgarlic. LWT- FoodScienceandTechnology,83,68–78.doi:10.1016/j.lwt.2017.03.059.

Siji,S.,&Nandini,P.V.(2017).ChemicalandnutrientcompositionofselectedbananavarietiesofKerala.International JournalofAdvancedEngineering,ManagementandScience,*3*(4),239829.

Singh,B.,Singh,J.P.,Kaur,A.,& Singh,N.(2016).Bioactivecompoundsin bananaand theirassociatedhealthbenefits–Areview.FoodChemistry, 206,1–11.doi:10.1016/j.foodchem.2016.03.033.

Sreedevi,L.,&Suma,D.A.(2015).ComparativeQualityanalysisofBananacv.Palayamkodan.InternationalJournalof Agricultural Research,4(4),6−11.

Sreejith,P.E.,& Sabu,M.(2017).Edible bananasofSouthIndia:Taxonomy &phytochemistry. India:Rheedea.

Suman,R.,Kalaimathi,K.,Palanichamy, S.,Sowmiya,R.,Vaganan,M.M.,Ravi,I.,etal. (2018).Anti-cancerous activities ofanthocyaninsofbanana cv.Nendran(Musasp.)flower bractsagainsthumancolonand cervicalcancer celllines.IntJ CurrMicrobiol Appl Sci,7(12),2786–2793.doi:10.20546/ijcmas.2018.712.316.

Szajdek, A.,& Borowska,E.J.(2008).Bioactive compounds andhealth-promotingproperties ofberry fruits: a review.Plant Foods HumNutr, *63*,147-156.

Tirkey,T.,Agarwal,S.,&Pandey,S.D.(2003).Effectof organicmanuresongrowth,maturityandyieldofbananacv.Dwarf Cavendish.SouthIndianHorticulture, 50,19−24.

Vanilarasu,G.B.,&Soorianatha,S.(2014).Influenceoforganicmanuresandamendmentsongrowth,flowering,yield, quality andpostharvest lifeofbanana cv. Grandnaine.IntJ EnvironSci, (4), 147−152.

Venkatarayappa,T.,Narasham,B.,&Venkatesan,C.(1976).Effectofpost-shootingapplicationofureaondevelopment and compositionof bananafruit. SouthIndianHorticulture, 19, 109–117.

Wyman,H.,& Palmer,J. K.(1964). Organicacids in theripeningbanana fruit.Plantphysiology,39(4), 630.