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Producing fuel ethanol from energy hygrophyte duckweed

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Abstract: throughComponentanalysis tokindofduckweeds,3Highstarchvaritieswere screenedout:spirodela oligorrhizaS3, [],[]]S1thenSpirodelaPolyrhizaV7,thecorrespondingstarch contentswas47.86%,41.45%and39.69%.accordingTo thestructuralcharacteristicofduckweed,hydrolysisEfficiencyof ofEnzymatichydrolysisanddifferentconcentrationsofacidHydrolysis,was compared,then,hydrolysistechnologywasconfirmedwhen theBoilingwaterBathfor 2Handacidconcentrationwas4mol/L,Thehydrolysisefficiencyreached93.52%.throughstudyingonEthanolfermentationfou ndOff thereasonthathydrolyteofduckweedCouldn ' tbefermentednormallyand ""fermentationEfficiencyof,Ethanolreached91.83%whenusingwaterextractstohy-drolyte.

Keywords: Energyhygrophyteduckweed;Starch;Fuelethanolsewagetreatment

Introduction

with the growing scarcity of fossil fuels and the days of eco-environmental loadBenefit-Add,World countries have implemented alternative energy development as an implementationImportant energy policies for sustainable economic development.in fuel ethanol productionraw material cost to total production cost70%~80%,and mainlyfrom corn and other food crops,have threatened global food securityall.cassava,sweet potato,non-grain ethanol, such as sugarcane, can avoid foodconsumption,but not highly industrialized,variety area limit obvious.combineLocal Resources Select reliable production material,take the road to pluralism,to

The development of biomass energy is of great practical significance.

Aquatic Plant growth does not occupy land,Solar energy autotrophic,to absorbnitrogen, phosphorus, and other nutrients in wastewater,growth Fast,growthperiodlength,containing starch that can be converted to fermented sugar,components such as cellulose,isPotential new materials applied to fuel ethanol development.current,only fewerReport on the production of fuel ethanol using aquatic energy plant fermentation.nigam[1],D.Mishima[2]andAshishKumar[3]will aquatic plantwater hyacinth,fiber ingredients in cabbage raw materials fermentation productionfuel ethanol;ChenYtry to ferment the starch from duckweed out of ethanol,Yields25.8%(Dry weight)[4].

duckweed(Lemnaceae)plant",acronym duckweed,atotalof4a covenant $A species,worldwidedistribution.mostof themare floating. Long in water flow relatively flat Lake River bend,through root or leafThebody absorbs the necessary nutrients such as nitrogen and phosphorus from water.duckweed birthLong long,can grow year-round in many warm tropics,propagation speedfast,2~7DBreeding generation,growth process consuming air$CO_2$and waterN,P,to reduce greenhouse gases,purify the body of water,AdsorptionHeavy Metal in water,can also be used to manage and beautify the environment,build manualWetlands etc.reported,1gduckweed Raw dry matter7dBuild$gdry Matter(Cumulative corn Biomass2.3g/g)[5],[H].Orontryshow,*Sewage can produce duckweed per yeart/hm[2][\Bieleskireportsthat,The purple-backed duckweed starch produced by sewage treatment contains83%~75%[],is a new type of starch for fuel ethanol.Quality raw

materials,can be used directly for energy production[9], toform a governance environment andThe sustainable development model of energy reuse.

is currently,Thereis no domestic use of aquatic plant fuel to produce BAlcohol related reports.This paper studies Aquatic Energy Plant duckweed productionFuel ethanol technology,filter for high starch varieties,test appropriate frontRationale and hydrolysis process,developing fuel ethanol production technology,SolidEfficient ethanol conversion of current aquatic energy plants,for fuel ethanol-Rawproduce alternative raw materials.

1. materials and methods1.1material

1.1 Duckweed from multiple regions at home and abroad(Table1).bacteria spawnwine yeastY-16,Theis the high ethanol obtained from mutation breeding in this laboratoryproducing strains.liquefying enzyme1toliquozymesupra,purchased from NorwayLetter Company,enzyme Alive$knu/g(1KNUpointing tot:,PH5.6Launchthe water5.26g/hamylasecontent);liquefaction Enzymes2purchased fromChengdu Kelon Reagent company.glucoamylase from Novozymes company,enzyme activityForce $aug/ml(AUGtoT:,PH4.3Launch Solution1mmol/minenzyme content for maltose).Other chemicals purchased fromallLong March chemical reagents company,is parse pure.

1.2 Instrumentation and devices

752spectrophotometer(Shanghai Kepler Instrument Limited publicDivision) 2200 Kjeldahlnitrogen Meter(Swedish fox company),multin/C2100Total organic carbon/Total nitrogen Analyzer(German Jena AnalyzerJoint AG),fuli9790gaschromatograph(zhejiang Fauli-Analysis Instruments Co., Ltd.).

1.3 test Methods

1.3.1 duckweed Plant and its hydrolysate composition analysis

through the duckweed starch,protein,Cellulose,Fat,GrayAll-component analysis,System classification and physiological ecology identification etcResearch,Analyzing collection of species,variety features and maincomponent Components,usingHPLCAnalysis Duckweed and its hydrolysatesugar Components,qualitative fermentation sugar species.

1.3.2 screening of high starch duckweed varieties

to determine the starch content of the collected varieties,Filter HighThe duckweed of starch content,as raw material for ethanol fermentation.

1.3.3 duckweed pretreatment process

enzymatichydrolysis:Grind The dried duckweed sample into a grinding,Toapplyamount to triangle bottle,Press1:2Add water blending,on121Zhangcook/min,takeout.then heat in a water bath tothe80~90Zhang,Add ConnaughtD-letter liquefaction enzyme,stirring,to iodine liquid detection is not blue.Coldbut to room temperature,Add1Seeglucoamylase Action4h.using salicylic acidcolorimetric Determination of reducing sugar content in samples,Calculate enzymatic hydrolysis efficiency.

acid hydrolysis:hydrolysis of samples using hydrochloric water solution,acid Strongdegrees1.2,2,4,6mol/l,,per feed ratio1:2Add acid"",Boiling water bath2H.Use Salicylic Acid Colorimetric method to determineThe reducing sugar content,Calculates acid hydrolysis efficiency.

1.3.4 duckweed ethanol fermentation

(1)Take the rightamount of dried dry powder,Press1.3.3pretreatmentProcess waterSolution Samples,after cooling,adjustmentpHto5,+Zhangsterilizationmin,prepare for fermentation with.

(2)After the sample is hydrolyzed,Centrifuge collectsupernatant,AdjustPHto5,sterilizationmin,prepare for fermentation.yeast seed liquid

Culture12~16H,10%inoculation to fermentation medium,inZhang,R/minCulture under shaker conditionsH.sampling test ethanolcontent,and calculate fermentation efficiency.

1.4 Profiling methods

acid hydrolysis-DNSmethod to determine the amount of starch in duckweed;Miningwith SwedenFOSS2200Determination of protein by automatic Kjeldahl nitrogen meter;byGB/T5009.10-2003Todetermine cellulose;Follow the referencedocument[ten]determining fat,Ash;using the Germanmultin/c2100type Total carbon Analyzer to determine carbon elements(C%);FollowtheGB7887-Todetermine phosphorus elements(P%);Determination of using high pressure liquidchromatographymonosaccharide components in hydrolysate,mobile phase to water,flow rate0.3ml/min,column TemperatureZhang;Use Salicylic Acid colorimetric method to determine reducing sugar;takestheGas chromatograph Determination of ethanol,load isTeam,Mobile phase is:Emptygas= 1:1(1ml/min),column TemperatureZhang,Sample FeedZhang,CheckprobeZhang.restore sugar contentstarch Contentx1.1fermentation efficiency=Results and discussions2.1Analysis of main components of duckweed plants

Aquatic plants and dryland energy sources have different properties andfeatures,need to develop compatible fuel ethanol pretreatment andfermentation process.Analyze the main components of duckweed,parse its groupTexture features,targeted pretreatment process,hydrolysis workerArts,Research on fermentation technology,Toprovide the duckweed for energy productionrevelation.from table2to see,The main ingredient in duckweed is starch,protein,cellulose,Ash,Low fat content, 5Ingredient Totalcontent to40%c~90%C,different varieties,Collection and culture conditionsThere are differences in the sample composition of the,like little root violetV5and multiple violetV5-1total content less than60%,islower than another4breed.duckweedelementanalysis shows,C,H,N,,P,Kelements have a certain amountof(table3),can be used directly for yeast growth and fermentation of ethanol.

accumulates,selection of high starch varieties for aquatic energy plant productionFuel Ethanol laying the foundation,for its development in energy and environmental protectionThe and leverages a large number of fine varieties.This experiment hastaken a large number of duckweed samplesat home and abroad, areas.(Table1),includes green-ping,Violetback duckweed,wuping etc4variety of species.Little root purple-pingS3starchcontent to47.86%,is an excellent variety for ethanol production,lessroot purple-S1and multi-root purple PingV7also high starch contenttype(Chart1).S3andS1all sameiless root purple ping,othersamples,especially green Ping did not select high starch products.Different varieties also have different effects in sewage treatment,GreenAllgrow fast,Clear Treatment effect,But active biomass contentLower,Violet Ping due to volume and leaf surface area generally greater than green ping,moretolerant in sewage than green-ping.Sewage treatment effect and healthsubstance starch content is the key factor for selecting good and practical varieties.t

diagram1Comparison of starch content of different duckweed varietiesFig.1Comparisontostarchcontentfromdifferent duckweedvarieties

2.3 duckweed pretreatment process

using duckweed varietiesS3hydrolysis Test.uses two kindsof non-the same liquefaction enzyme treatment substrate,Hydrolysis efficiency difference is not obvious(Chart2),Highest value is87.76%.hydrolysis rate of acid hydrolysis process is significantly not

and,acid concentration is1. 4~4mol/L,increases with acid concentration,

diagram2Two kinds of enzyme waterCompare efficiency comparisons

Fig. 2Comparisontohydrolysisefficiencytotwoenzymes DE(dextroseequivalent):glucose value,Table non-starch hydrolysis degree,nextSame.1,2:NOAA liquefaction treatment3,4:kelon liquefying enzyme treatment.80~,action until iodine is not changed blue.4Group with glucoamylase room temperature treatment4h.

hydrolysis efficiency gradually increases,4mol/land6mol/lhydrolysis Effectrate is essentially the same(Chart3),where4mol/lwith thehighest hydrolysis efficiencyto93.52%.results show,Current enzymatic hydrolysis is not completelyhydrolysis of duckweed,to meet the need for fuel ethanol fermentation,andexpensive;and acid water solution simple,Easy to implement,hydrolysisHigh Efficiency.test to confirm4mol/lHydrochloric acid boiling water bath hydrolysis2hfor best hydrolytic process,to prepare samples for fermentation using this method.

diagram3does notComparison of acid hydrolysis methods

Fig. 3Comparisontodifferentmethodstoacidhydrolysis

Concentration

duckweed Water extracts are mainly fiber sugar and other small amounts of polysaccharides,Basic glucose-free monosaccharide.hydrolysateHPLCpointsTheanalysis results indicate that,Duckweed In the extract of acid hydrolysis and enzymatic hydrolysisin glucose and small Arabic sugar,xylose,glucose is predominantly(),% total reducing sugar75%around,Enzyme hydrolysis Productmore complex than acid hydrolysate.

2.4 duckweed ethanol fermentation

2.4.1duckweed full residue ethanol fermentation

fermentation results of different species of duckweed and glucose controlas table4:,Duckweed has the highest fermentation efficiency48.1%,minimum13.3%,below glucose control41%~76%.full-time fermentation is the most commonly used raw material fermentation method,Toavoid extractingAdd to the cost of fermenting sugar and complex operations,alsotheprovides many other nutrients.experiment_Direct try allStudy on the method of residue fermentation for producing fuel ethanol from duckweed.liquid ratioto1:10time,fermentation efficiency48.08%;The liquid ratio is1:2,

fermentation efficiency is37.56%.fermentation results show,duckweed full slag straightConnectto ferment,efficiency is inversely proportional to the material ratio,Thelarger the concentration,fermentation effectTherate is significantly lower.

when fermenting with duckweed residue,fermentation basic cannot beoften,thepresence of a large amount of chlorophyll makes the ferment dark green,LeafGreen element,anthocyanin,fermentation of non-starch such as flavonoidsPossible suppression of procedures[one],[A].also,on hydrolyzed substrate overin,Dilute acid not only hydrolysis of starch,will also be used for cellulose and so on to produceToxic substances such as furfural[A],suppresses fermentation,oris pretreatment acid or enzymatic hydrolysis not completely,cause low fermentation efficiency.testsolid-Liquid separation of duckweed hydrolysates,looking for increased fermentation effectrate,and analyze the reason why the fermentation efficiency of duckweed residue is low.2.4.2duckweed hydrolysis solid residue ethanol fermentation

to add the residue of the duckweed hydrolysate after solid-liquid separation18%Portuguesegrape sugar,ethanol fermentation,fermenth after,Test groupfermentationmaximum efficiency34.7%,Lowest29.6%,is lower fermentationefficiency(table5),The fermentation efficiency of the control group is89.8%,indicates duckweedhydrolysis residue cannot direct fuel ethanol fermentation,which may be savedon substances inhibiting yeast fermentation.

because Duckweed is traditional Chinese medicine,where the medicinal substances of the OsmanthusLavender,celery to multi-hydroxy flavonoids[A],has bacteriostasis[a],Total residue fermentation cannot avoid these ingredients to yeast growth and produce BEffect of the alcohol process.in the hydrolysis and fermentation process,These ingredients are notThebreak out increases the likelihood of suppressing fermentation.

Experiment to further study the morphology of yeast in fermentation residue,Viewto observe the presence of yeast inhibition.withXmoil MirrorThefungus in the culture medium,in culture medium containing duckweed slagyeast germ body diameterIt's the same.1mm, issignificantly smaller than the control group of bacteria largeSmall,and there is a phenomenon of yeast fragmentation()4(B),Portuguesegrape sugar Control body intact.Theresult shows that,, duckweed residue,in the bacteriostatic component,causes yeast to take shape and physiology changes,Toinhibit ethanol fermentation.

2.4.3duckweed Hydrolysis solution ethanol fermentation

take a little root violetS3Ethanol fermentation,starch content is47.86%,extracts hydrolysis supernatant fermentation,maximum fermentation efficiency is91.83% (Table6).Solid-liquid separation of duckweed hydrolysates,withsoluble sugar liquid fermentation,promoting duckweed ethanol fermentation.

Table6Comparison of fermentation efficiency of two hydrolysis modes

Table6Comparison of hydrolysis efficiencyof process of extracting sugar after hydrolysis,The adds the fermented sugar to theOther ingredients separate use,help increase ethanol fermentation efficiency,andForOther useful ingredients(such as flavonoids)further application of.

3. Epilogue

with the continuous development of our society,large amounts of contaminated water andthe production of domestic sewage becomes environmental and ecological balance_catastrophetitle,Developing aquatic energy plants can combine these two aspects.This trial shows the use of aquatic energy plant duckweed for renewable energiesavailability of fuel ethanol production,after the duckweed is hydrolyzed to the whole plant,mentioningtake sugar liquid for fuel ethanol fermentation,max fermentation efficiency upto91.83%,Clean water quality,also provides raw materials for energy production,realTechnology development coupled with current energy production and environmental governance.

References

1. Nigam JN.Bioconversion of WA Ter-hyacinth
2. Mishima D,kuniki M,SEI K,*et al*. ethanol

production from candidate Energy Crops:water Hyacinth(Eichhornia crassipes)andwater lettuce(Pistia stratiotesL.)[J].bioresourceTechnology,2008,(7):2495-2500.

3. KUMAR A,SINGH LK,Sanjoy bioconversion of lignocellulosic fraction of Water-hyacinth (EichhorniaCrassipes) hemicellulose acid hydrolysate to ethanolbyPichia stipitis[J].BioresourceTechnology,2009, +(,):3293-3297.
4. CHEN Y,Yablonski M,ERNST E,etAt.Duckweed:an Alternative starch Source for bioethanol Production [C].Michigan:Asabe Regional Annual Conference,2007.
5. KRISHNA KCB,Polprasert C.An integrated kinetic model for organic and nutrient removal by duckweed-based wastewater Treatment (Dubwat) system [J].EcologicalEngineering,2008,,(3):243-250.
6. Culley,JR DD,Rejmankova E,etAt.Production, chemical quality, and use of Duckweed(Lemnaceae)in aquaculture, waster management, and animal feeds [J].J.WorldMaric.Soc.,1981,(2):27-29.
7. ORON G. Duckweed culture for Wasterwater renovation andbiomass production [J].agricuturalWater Management,1994,(1):27-40.
8. Bieleski RL.Effect of phosphorus deficienoy on levels ofphosphorus compoundsinSpirodela[J].Plant physiol.,1968,(8):1309-1316.
9. CHENG JJ,STOMP AM.Growing duckweed to recover Nutrients from wastewaters and forproduction of fuel ethanol and animal feeds [J].clean-soilAirwate,2009,$(1):17-26.
10. Ningzheng.Food Analysis manual[M].Beijing:China Light Industry press,1998.145-147.
11. Lingyun,What boardis,Baoyan.Study on the chemical constituents of duckweed[J].in GrassDrugs,1999(2):88-90.
12. LinChuohui.Study on antimicrobial activity of Luteolin[J].Test Medicine and clinical,2009,6([):1022,seal3.
13. Pan,LiuYan.The toxicity of cellulose ethanol fermentation by acid solution[J].LiveTechnology,2002,(1):45-47.

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