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Distribution.β-Glucan, phenolic Acids. Oat Bran (Avena nuda) Processing. Oat Rice, Oat Flour

Jiangfeng Li

Biological Engineering, Jiangsu University

Abstract: Proportion, microstructure. oat bran, endosperm. analyzed. several selected typical cultivars. Naked Oat (Avena nuda).. Same time, distribution profiles.β-Glucan, phenolic acids. oat bran (pericarp, seed coat. aleurone layer), endosperm. tested. establish a method. determining. processing suitability. oats rice, oat flour. finally, method. used. verify. suitability. existing mainstream processing technologies. oat rice, oat flour. showed,. selected varieties,β-Glucan was mostly enriched in the bran containing a value of 85.7 mg/G, which was about 4.5 times higher than that in endosperm. Moreover, the contentsP-Coomaric acid and ferulic acid in oat bran were 0.099 and 1.00 mg/G, which were 24 and 48 times higher than thought in endosperm, review. In addition, the contentsP-Coomaric acid and ferulic acid in pericarp were 13 and 2.7 times higher than then in Testa + alonne layer, review. The average contentBeta-Glucan in the second bran obtained from Oat rice processing was 1.7%, Which was far lower than that in oat branBeta-Glucan in the fourth and fifth Brans obtained from oat flour processing were 6.73%And 7.80%, When were close to that in oat bran, suggesting the processing was intensive. In connection, by analyzing the contentsBeta-Glucan and phenol acids in the oat bran targeted by typing, we can determine the processing degree of oat products, which will provide technical support for oat processing.

Keywords: Oat rice; oat flour; processing suitability; oat bran;Beta-Glucan

Naked Oats (Avena nuda) Is an important functional grain originated in China, which is mainly cultivated in alpine and hilly areas of north China, northwest, Northeast and Southwest China.[1]. Like foreign oats, naked oats are rich inBeta-Dextran, unsaturated fatty acids, phenolic acids, oat Alkaloids and other functional components[2-3]. Research shows that oatsBeta-Dextran can be covered in the intestinal mucosa to slow down the absorption of sugar, fat and cholesterol[4]. Meanwhile,Beta-Dextran can bind to bile acid, promote its excretion in vitro with feces, promote the decomposition of cholesterol in vivo, and reduce serum cholesterol.[5-6]. Therefore, oats are recognized as the Food and Drug Administration of the United States and the World Health Organization as having the function of lowering cholesterol and stabilizing blood glucose.[7].

Currently, oats have been developed for a variety of foods. In addition to oatmeal, oatmeal bread and other western food[8]It also includes traditional staple food products or raw materials, such as naked oats, instant noodles with oats, oat rice and whole oat flour. Among them, the supply of oat flour and oat rice in the domestic market is in short supply[9]. The processing of Yan Mai Rice originated from20Century80Age, can be divided into "non-broken" and "broken" two categories[10]. The original Processing Technology of oat rice could not get rid of the hydrophobic structure such as peel and seed coat, which had poor water absorption and could not achieve "same boiling and ripening ". Therefore, the food

is inconvenient and the promotion is limited[11]. In recent years, the production units have added grinding process to remove the hydrophobic structure of oat grains on the basis of the original oat rice process, which greatly improved the cooking characteristics of oat rice.[12]. Although the OAT rice processed by the new technology can be "cooked with rice", the ground rice is easy to damage the paste layer, resulting inBeta-Glucan of a large number of loss; at the same time easy to lead to fat and lipase contact and lead to rancidity reduce oat rice of storage stability. So new processing oat rice of process in whether to keep?β-Dextran, phenolic acids and components become optimization processing process of key. Oat powder is processing oat noodles, oat bread and cookies and food of Raw Materials its quality directly decided to the oats food of nutrition quality. However due to rich in glucan of oat bran difficult to broken oat products of Palatability more was give up great reduce the oat powder of nutritional. How to in try to assurance oat powder in nutritional of premise. Removal lignification epidermal is oat powder processing of key.

In short, the optimization oat rice and oats powder of processing suitable for of need to clear oat grain outer edge structure (peel, seed coat, aleurone layer) inβ-Dextran, phenolic acid and nutrition components of distribution characteristics and proven its in processing process in. For this experimental quasi-by determinationβ-Dextran and main phenolic acids in oat grain structure layer in distribution and analysis oat milling MIG and oat powder of processing by-product inβ-Dextran and phenolic acids of content determine its in processing process in main flow for oats staple food products and raw materials of moderate processing evaluation provide theory support.

1.1 Material and reagent

Oat grain (DAM naked oats1,3,5, And6,) Shanxi Taiyuan liu wei zhai industrial limited the company;β-Dextran determination kit IrelandMegazymeThe company; acid fuchsin, purification agar powder,25%Glutaraldehyde solution, anhydrous ethanol, sodium dihydrogen phosphate, sodium hydroxide, sodium acetate, glacial acetic acid, gallic acid, forint-Phenol reagent, concentrated hydrochloric acid, ethyl acetate, sodium hydroxide, three fluorine acetic acid, methanol (chromatographically pure), acetonitrile (chromatographically pure) Chinese medicine group chemical reagent limited the company; fluorescence whitening agent (F l u e n t brighter 28),3,4 5-Three methoxy cinnamic acid, coumaric acid, ferulic acid AmericanSigmaThe company.

1.2 Instrument and Equipment

1260High performance liquid chromatography,Eclipse Plus Phenyl-hexylColumn (250 mm×4.6 mm5 Mu m) American Agilent Science and Technology Limited the company;DMI4000BInverted fluorescence microscope Germany Leica the company;Cary100UV-Visible system American Varian the company; Nitrogen blowing instrument amp Science and Technology Limited the company; gas bath constant temperature oscillator,HH-SDigital constant temperature water bath Shanghai, jing hong Experimental Equipment limited the company;RE-2000Rotating evaporator Shanghai, ya rong biochemical instrument factory;PHOf sartorius instrument limited the company;KQ-300DENumerical control ultrasonic cleaner Kunshan ultrasonic instrument limited the company;HB43-SHalogen Moisture Analyzer mettler-Toledo instrument (Shanghai) limited the company; electrothermal constant-temperature blast drying oven Shanghai, Permanent Science and Technology Limited the company;6NS-33Style gold card rice mill Shanxi bei sheng Mechanical Manufacturing Limited the company;6F22Style mill Zhengzhou double sails food mechanical limited the company.

1.3 Methods

1.3.1 Raw materials Pretreatment

Take about5 gOf oat grain will its in4℃ To ion water soaking24 HRemoval germ use tweezers auxiliary stripping oats peel then in continue soaking to oat soft. With knife along the longitudinal abdominal the ditch will be oats open will internal endosperm gently scraped off respectively get contains oats Layer-Aleurone layer of seed coat. Will get the seed coat put to ion water make endosperm wet further scraping to the seed coat of endosperm. The dry after the peel, aleurone layer + seed coat and endosperm respectively in40℃ Drying and said quality calculation oats

peel, aleurone layer + seed coat and endosperm of proportion. Finally use mortar will system have to of sample grinding into powder.60Mesh sieve preservation in dryer in standby.

Oat rice and oats powder principal Shanxi Taiyuan liu wei zhai industrial limited the company processing get. Oat rice of processing process: oat grain → clean up play hair → water → baking out enzyme → drying → peeling → Quantitative Packaging off roll speed250 R/MinFeed Rate10 kg/Min; Rice milling two times the on-bran for the first1~2Road bran. Oat powder of processing process: oats

Grain clean up → washing → frying → milling → mechanical, screening, oat flour and wheat bran. Milling5Roll in different Roll End screening collected bran for the first1~5Road bran.

1.3.2 Oat Bran of micro-structure analysis

Surface micro-structure analysis: Take appropriate amount oats structure layer placed slide on join2~3Drop to water make sample dispersion uniform cover coverslip placed microscope under observation select has representative of pictures.

Cross section structure slice of preparation: Take15 mLTo water in25 mLBeaker in join1 gAgar after placed in boiling water bath dissolved. Add0.5 gOats structure Layer Powder stirring uniform use ultrasonic degassing (degassing during temperature not lower than that?45℃). Degassing after quickly will beaker placed-18℃ Stay agar solidification after cut1 LengthSquare small. Will agar placed1%Glutaraldehyde solution in12 HThen use frozen slicer cut-out thickness8 Mu mSheet placed slide on dry after respectively1%Acid fuchsin-Ethanol solution and0.01%Fluorescence whitening agent-Aqueous Solution Staining2 minWash staining solution (soaking in to water about2 minRepeat3Times) Dry mounting then the fluorescence observation. Using Fluorescence Microscope (400~410 nm) The observation select has representative of samples pictures.

1.3.3 Samples in water, protein, crude fat, starch andβ-Glucan of Determination

Respectively referenceGB/T 5009.3-2010The food in the water of determination of methods,GB/T 5009.5-2010The food in protein of determination of methods,GB/T 5009.6-2003The food in crude fat of determination of methods andAACC method 76.13[13]Food in starch of determination methods the determination.β-Glucan content reference kit in with the operation methods the determination.

1.3.4 Oat grain structure in phenolic acid content of Determination

Phenolic acids of Extraction Methods[14]: WeighingNatural 20 mgSample placed bottle join10 mLOf2.0 Mol/LOfNaOHSolution filling into nitrogen after add50 Mu LQuality concentration1.02 mg/MLOf3,4 5-Three methoxy cinnamic acid (50%Methanol solution dissolved) as an in standard of into constant temperature shaker in35 ℃ ,120 R/MinOf conditions under dark in hydrolysis2 H; Hydrolysis after use6 Mol/LOf hydrochloride adjustment SolutionPHValue2Use40 mLOf ethyl acetate in separatory funnel in Extraction2Times pay more attention times mixing make extraction fully. Will extraction of Ethyl Acetate Extract with in rotating evaporation instrument concentration1~2 mLUse nitrogen dry join0.8 mLOf50%Methanol solution dissolved and"0.45 Mu mOrganic Phase Filter seal cold storage.

Phenolic acids of High Performance Liquid Chromatography Determination Methods: chromatographic column:Eclipse Plus Phenyl-hexylColumn (250 mm×4.6 mm5 Mu m); Detector: UV detector; wavelength:325 nm; Into-like:Natural 20 Mu L; Mobile phase:A:1 mmol/LThree fluorine acetic acid solution;B: Acetonitrile-1 mmol/LThree

Of acetic acid solution (90 10V/V); Flow rate:1 ml/Min; Column temperature:

45℃; Mobile phase gradient:0~15 min:85% ;15~Natural 20 min:

82% ;Natural 20~25 min:80% ;25~55 min:72% ;

55~58 min:55% ;58~60 min:85% [15].

To ferulic acid, coumaric acid as an standard draw standard curve (R^2Are0.999) Use standard curve of chromatographic peaks are quantitative analysis.

1.4 Data Statistics

TheSPSS 22Software of experimental data the significant and variance analysis results3Times determination data$\bar{x}$±SSaid.

2.1 Oat Bran structure layer of micro-characteristics and PROPORTION ANALYSIS

2.1.1 Oat Bran structure layer of Micro Structure Characteristics

In monocotyledonous grain in bran General by peel, seed coat and aleurone layer[16]. Oat Bran structure layer of micro characteristics is qualitative determination oats processing degree of basic. Figure1aShowed that oat peel by narrow fibrous cells color yellowish in microscope under light transmittance high; and Seed Coat + aleurone layer by polygon cells easy to distinguish (figure1B) Color brown (from seed coat). Figure1c,1DFor broken after of oat peel, seed coat + aleurone layer structure layer in oat bran structure layer cells don't was completely broken of conditions under peel and aleurone layer is also easy to resolution. So use optical microscope can be qualitative determination oat powder or oat rice processing the removal components of micro structure to determine its nutrition components loss.

From figure2aCan see oat grain outermost layer for thin peel secondly for bright green of aleurone layer (was fluorescence whitening agent staining after) inner layer of endosperm (starch and protein) for blue black this andChen ZhongweiSuch.[17]The wheat grain of staining results similar due to the "with the microscope

For pseudo-color the display of color different (aleurone layer of actual color for bright blue); aleurone layer cross section micro-structure in figure2bIn more obvious (has stripping peel). So from cross section structure can determine oat bran and endosperm of there state to qualitative determination oat bran of grinding degree and nutrition components loss situation.

2.1.2 Oat Bran of content

Note: within the different lowercase letters said difference significant,$P<0.05$. The same below.

Oat rice of processing degree can also be through analysis the removal of oat bran of proportion to determine this need to analysis oat bran and endosperm content. Such as table1Shown in endosperm and bran of quality ratio3 1Bran of proportion22.3%~24.4%Quality score average23.4%; Endosperm of proportion75.3%~77.4%Quality score average76.3%(In manual peel off process in will loss a small amount of endosperm). From table1Can see,4A oat varieties in wheat bran and endosperm quality fraction close to but specific varieties between existence certain difference.

In addition and wheat different oats in aleurone layer and endosperm of boundaries don't very obvious so general of oat bran adhesion the large number of times aleurone layer[18]. So conventional oat milling income oat bran quality fraction great in23%[19-20]. Table1In the column oat bran of quality fraction General as an determine bran completely stripped of critical value for determination oat rice and oats milling of processing degree.

2.2O at grain structure and powder basic this components,β-Dextran and main phenolic acid content

2.2.1 4A oats varieties of basic composition analysis

Such as table2Shown in,4A oats varieties of powder water quality score11.47%~12.41%Between average11.92%. Which dam naked oats3, Of water quality score highest12.41%; Dam naked oats1, Water quality score minimum11.47%. Overall,4A oats varieties water content difference is not obvious but were in security water of lower limit; oat powder of protein quality score15.62%~18.57%Between average17.24%.

Which dam naked oats3, Protein quality score highest18.57%; Dam naked oats1, Protein quality score minimum15.62%; Crude fat quality fraction

6.69%~7.91%Average7.32%. Dam naked oats1, Crude fat content Highest Dam naked oats5Lowest quality score6.69%; And4Of oat varieties of starch quality score42.85%~49.76%Which dam naked oats1 Content minimum dam naked oats3, Content highest starch quality score average44.83%.

2.2.2 Oat grain structure and powder inβ-Glucan content

The based onAACCMethods improved the kit method of oat bran, endosperm and powder inβ-Glucan of content analysis results see table3.4A oat varieties of powder inβ-Dextran quality score2.97%~4.02%Average3.58%. Guo Lina[21]Had determination.31Of domestic oats in

-Glucan of content its average quality score4.56%Amplitude 2.79%~5.63%This experimental determination results in its range in.

However oat branβ-Glucan content was significantly higher than that of endosperm. Such

3Shown in,4A oat varieties bran inβ-Mass fraction of Dextran

6.43%~10.32%Between, the average mass fraction is85.7%In the endosperm of oatsBeta-Average dextran mass fraction only1.89%General Introduction 1.77%~2.18%Between. Thus, for naked oats,

Beta-Dextran is mainly concentrated in wheat bran, and its mass fraction is about the middle quality of endosperm.

Quantity score4.5 yenTimes, for the whole Powder2.1 yenTimes. Shen ruiling[22]The content of dextran in oat bran from Inner Mongolia, Shanxi and Hebei was analyzed.

The results also showed that soluble in oat branBeta-Dextran mass fraction in 6.7.%~9.2%Between, and in the OAT EndospermBeta-Dextran mass fraction 1.5.%. There are also studies showing that the oatmeal sub-paste layer is rich inBeta-Dextran[23]But it does not conflict with the purpose of this experiment.

Union table1.The proportion of wheat bran and endosperm in oat branBeta-The total amount of dextran is about the whole oat powder.40%It is an important source of functional components of oat whole powder. Therefore, Bran should be retained as much as possible in oat processing, especially the paste layer.[24]. At the same time, the experimental data also provide a reference for determining the suitability of oat processing.

2.2.3 Analysis of Phenolic Acids in grain structure of different oats

The composition and content of Phenolic Acids in oat grains were determined by HPLC. The results showed that the main phenolic acids in oat bran and endosperm were ferulic acid and coumaric acid.11.82 minAnd14.77 min).

The content of ferulic acid is the largest, which is similar to the composition of Phenolic Acids in wheat and other cereals.[25]. The content of main phenolic acids4..

From table4The,4Of oat bran in ferulic acid content0.73~1.24 mg/GBetween average content1.00 mg/G. Which dam naked oats3, Of bran in content was significantly higher than that of other3A varieties. Bran inP-Coumaric acid content0.08~0.14 mg/GBetween which dam naked oats1, Bran in phenolic acid content highest. In addition by analysis oat bran of peel, seed coat + aleurone layer in phenol acid shows that oats peel in ferulic acid andP-Coumaric acid respectively3.27 mg/GAnd1.31 mg/G(Table5) Was significantly higher than that of the in seed coat + aleurone layer in content this and wheat and grain in phenolic acids of distribution similar[25].

In endosperm in,4Of oats in endosperm ferulic acid andP-Coumaric acid average content respectively0.021 mg/GAnd0.004 mg/GFar lower than oat bran in Content. Bran in ferulic acid andP-Coumaric acid of content respectively about for endosperm in content48Times and24Times, this with Hao Jie etc.[26]The results are similar.

In conclusion, the main phenolic acids in oat were ferulic acid, which was mainly concentrated in wheat bran. The results were consistent with the results of fluorescence color of oat grains.

2.3 Wheat Bran from oat flour and oat flourBeta-Analysis of dextran, phenolic acids and total phenols

2.3.1 Wheat Bran from oat flour and oat flourBeta-Dextran Content Analysis

Yōba3.From the processing of oat rice1.Dahe2.Wheat Bran and whole oat flour1.~5.Bran, analyzeBeta-Content of dextran and phenolic acids.

Table6.As shown in the first1.,2.Middle of wheat branBeta-Dextran mass fraction was1.75%And1.71%, Contrast table3.The results showed that the rice peeling process used may only remove some of the pericarp and did not destroy the aleurone cells,Beta-Dextran loss is not much. Wang Chao[27]The study also shows that the main purpose of the latest yanmai rice peeling process is to reduce the loss of the paste layer.

In the bran made from oat flour,Beta-The content of dextran gradually increased with the degree of grinding.4.,5.Middle of wheat branBeta-Dextran mass fraction respectively6.73%And7.80%, And hand-stripped oat branBeta-The content of dextran is similar. The results showed that the cells of oat paste layer were damaged,Beta-Dextran loss is serious. Yang Jinzhi[28]Compared with the difference between the mechanical crushing

and the conventional grinding process, it was found that the loss of dextran in the oat flour from the conventional grinding powder was larger. Therefore, in the course of oat flour processing,4.Tao Ji5.The oat bran was added to the oat flour to reduce the loss of functional components.

2.3.2 Analysis of Phenolic Acids in bran from oat flour and oat rice

By table7.We can know that the first1.Dao bran and2.The content of coumaric acid in wheat bran was significantly different.1.The content of coumaric acid in wheat bran was0.264 mg/G, And the first2.Only in the wheat bran0.050 mg/G2.1.The content of ferulic acid in Wheat Bran1.193 mg/G, No.2.The bran content is0.347 mg/G. The results showed that the loss of major phenolic acids, such as coumaric acid and ferulic acid, was significant during rice preparation. Due to the peel inP-The content of coumaric acid and ferulic acid was the highest (Table5.), It can be inferred that the grinding process of oat rice may mainly remove a large amount of peel.

In the process of oat flour milling, with the increase of the Processing Accuracy of oat flour, the content0.068 mg/GAnd0.227 mg/GGradually increased0.103 mg/GAnd0.475 mg/GThe results showed that the loss of phenolic acids, such as coumaric acid and ferulic acid, was larger in the Process of flour milling.[29]The results are similar. You should reduce the amount of oat bran.

In addition to the degree, reserve3.~5.Oat Bran from the middle of the road to obtain oat flour rich in phenolic acids[30].

In the grain of naked oats,Beta-Dextran is mainly concentrated in wheat bran, BranBeta-The average mass fraction of dextran was8.57%About the content of endosperm 4.5 yenTimes.4.Seeds of naked oat whole PowderBeta-The average mass fraction of dextran was4.00%Of between no significant difference; oat grain contained main salvianolic acid as ferulic acid andP-Coumaric acid especially is ferulic acid and main enrichment in bran in. And in bran in Peel inP-Coumaric acid and ferulic acid of content much higher than in seed coat + aleurone layer in; in oat rice peeling processing in grinding the removal of bran inβ-Dextran quality score1.71%Far less than aleurone layer in content ferulic acid and coumaric acid of loss are more combined with both of results show that

Oat rice removal most of peel keep the mostβ-Dextran processing process appropriate; and in oat Milling Process in from the first3Road bran start the removal of bran inβ-Dextran quality fraction up5.6%Ferulic acid and phenolic acids of loss also is big this show that oat Milling Process in loss the moreβ-Dextran. So for keep oats in Dextran should be in the first3Road after oat flour grinding milling and backfill to keep more of useful functional components.

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