The ability of absorption and physicochemical properties of chitosan prepared from fungi

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Abstract

The physicochemical properties of fungal chitosan at 95℃ and 40℃ acid treatment was as follows respectively. The nitrogen content was 6.71%, 6.91%, the viscosity 2.23cps, 2.21cps, the acetylation 12.0%, 12.7% and the molecular weight 3.12×10^5Dalton, 3.01×10^5Dalton. The absorbency band of reference, FCs-40 and FCs-95 in I.R. spectra was almost in accord with one another. In solid state NMR spectra, methyl group($-CH_3$) was observed lightly. That means which deacetylation was well occurred. Carbonyl group(C=O) was not observed. C_1 to C_6 in solid state NMR was well observed seperately enough.

Introduction

Commercially available chitosan is usually manufactured from crustacean shell chitin by deacetylating with a hot(over 100℃) concentrated sodium hydroxide solution(30～50%). This treatment eliminates the acetate groups from the amine of C_2 group. This process of chitosan prepared from crustacean shells requires large amounts of heat and caustic alkali. And such conversion appears to have limited potential for industrial acceptance because of seasonal and limited supply, high processing cost, processing difficulties, and inconsitent physicochemical characteristics of chitosan. Recent advances in fermentation technology suggested that many of this problems can be overcome by culturing fungi. In the functional properties, chitosan is a biopolymer used for the production of biodegradable films, viscosity-control agents, dye binding capacity, emulsion stability agents, flocculating and chelating agents in wastewater treatments with great potential for industrial use due to its high amine content and polycationic nature. The object of this study was to produce chitosan(called fungal chitosan or FCs) from the mycelium of Absidia coerulea, then, to experiment of physicochemical properties of fungal chitosan and of properties of function involving the ability of pigment

absorption, the ability of emulsification, and the absorption force of fat.

Materials and Methods

Strains : Absidia coerulea IFO5301
Culture Instrument : Continuous Bio-reactor(KF-25L, Korea Fermentor)

Materials

Chitosans : SCs(Sigma Co., USA), FCs40(acid treatment at 40℃),
FCs95(acid treatment at 95℃),
JCs(Commercial products, Japan)
Chitins : SCt(Sigma Co., USA), MCt(MIT bioeng. lab., USA)
Edible colorant : FD&C Red No. 3
Edible oil : Soybean oil, Dongbang Co.

Methods

Chemical conpositions : AOAC methods
Viscosity : Capillary viscometer, Cannon Ins. Co., USA
Molecular weight : Mark-Houwink viscosity equation
Acetylation degree : Sannan et al. methods
I.R. spectrum : Bruker IFS 66 FT-IR, Germany
NMR spectrum : Bruker MSL 200, Germany
Dye binding capacity : UV spectrophotometer, Absorbance at 505nm
Fat binding capacity & Emulsification : Lin et al. methods

Results and Discussion

In flask incubation, *Absidia coerulea* IFO5301 had highest yield in FCs/DCW, 258㎎/200㎖ at initial pH 6.5, temperature 27℃, culture time 6days. In batch bioreactor, the optimum cultivation condition was that cell suspended solution was 70㎖, aeration rate 0.5 ℓ /min, agitation rate 800rpm, culture time 36hr. In continuous bioreactor, the optimum substrate flow rate was 4 ℓ /day. Among the cultivation hours, 24hr, 36hr, 48hr, the yields of FCs/AIM was 58.5% in 36hr, higher than the others. In the experiment according to the temperature of acid treatment, the yield of FCs was higher at 95℃ than at 40℃. The colors were, in turn, cream white and brown. The chemical composition and physicochemical properties of fungal chitosan at 95℃ and 40℃ acid treatment was as follows respectively. The moisture was 6.58%, 6.57%, the nitrogen content 6.71%, 6.91%, the yield of FCs/DCW 16.10%, 15.64%, the solubility 99.05%, 99.13%, the viscosity 2.23cps, 2.21cps, the acetylation 12.0%, 12.7% and the molecular weight 3.12×10^5Dalton, 3.01×10^5 Dalton. From the above facts, according

to the temperature of acid treatment, the components and physicochemical properties of two kinds of fungal chitosan had little difference. From the I.R. spectra, the absorption bands at 1655 cm^{-1}(amide I), 1550 cm^{-1}(amide II) of fungal and reference chitosans became very weak, similarly. In solid state NMR spectra, reference and two FCs were also in accord with one another. In 2.1ppm of solid state NMR spectra, resolution that was appeared methyl group($-CH_3$) was observed lightly. That means which deacetylation was well occurred. Carbonyl group(C=O) part was not observed. C_1 to C_6 in solid state NMR was well observed seperately enough. Chemical shift of ^{13}C-NMR spectra of fungal and reference chitosans were in good agreement with slight experimental deviation. In the experiment of functional properties of FCs-40, the ability of pigment absorption was 44.68㎎ dye/g sample, the ability of emulsification 65%, the absorption force of fat 416%.

Conclusion

The physicochemical properties of fungal chitosans(FCs95 and FCs40) were as follows respectively. The moisture was 6.58%, 6.57%, the nitrogen content 6.71%, 6.91%, the yield of FCs/DCW 16.10%, 15.64%, the solubility 99.05%, 99.13%, the viscosity 2.23cps, 2.21cps, the acetylation 12.0%, 12.7% and the molecular weight 3.12×10^5 Dalton, 3.01×10^5 Dalton. The absorbency band of reference, FCs40 and FCs95 in I.R. spectra was almost in accord with one another. In solid state NMR spectra, reference and two FCs were also in accord with one another. Carbonyl group(C=O) part was not observed. C_1 to C_6 in solid state NMR was well observed seperately enough. In the experiment of functional properties of FCs40, the ability of pigment absorption was 44.68㎎ dye/g sample, the ability of emulsification 65%, the absorption force of fat 416%.

References

Kobayashi, T., Takiguchi, Y., Shimahara, K. and Sanan, T. : Distribution of chitosan in Absidia strains and some properties of the chitosan isolated. *Nippon Nogeikagaku Kaishi.*, 62,1463-1469, 1988.

Rane, K. D. and Hoover, D. G. : Production of chitosan by fungi. In Dekker, M.(ed). *Food Biotechnology*, 1993.

Lee, V.F.P. : Solution and shear properties of chitin and chitosan. Ph. D. Thesis, University of Washington. 14-44, 1978.

Sannan,T., Kurita, K., Ogura, K. and Iwakura, Y. : Studies on the chitin, 7. Infrared spectroscopic determination of degree of deacetylation. *Polymer*, 19, 458-459, 1978.

Lin, M.J.Y., Humbort. E.S. and Sosulki, F.W. : Certain functional properties of sunflower meals. *J. Food Sci.*, 39, 368-371, 1974.

Sannan,T., Kurita, K., and Iwakura,Y. : Studies on chitin 2: Effect of deacetylation of

solubility. *Macromol. chem.*, 177, 3589-3600, 1976.

Magnolate, D. : A process for deacidifying a coffee extract and the deacidified extract obtained, UK patent Application GB 2029. 688A, 1978.

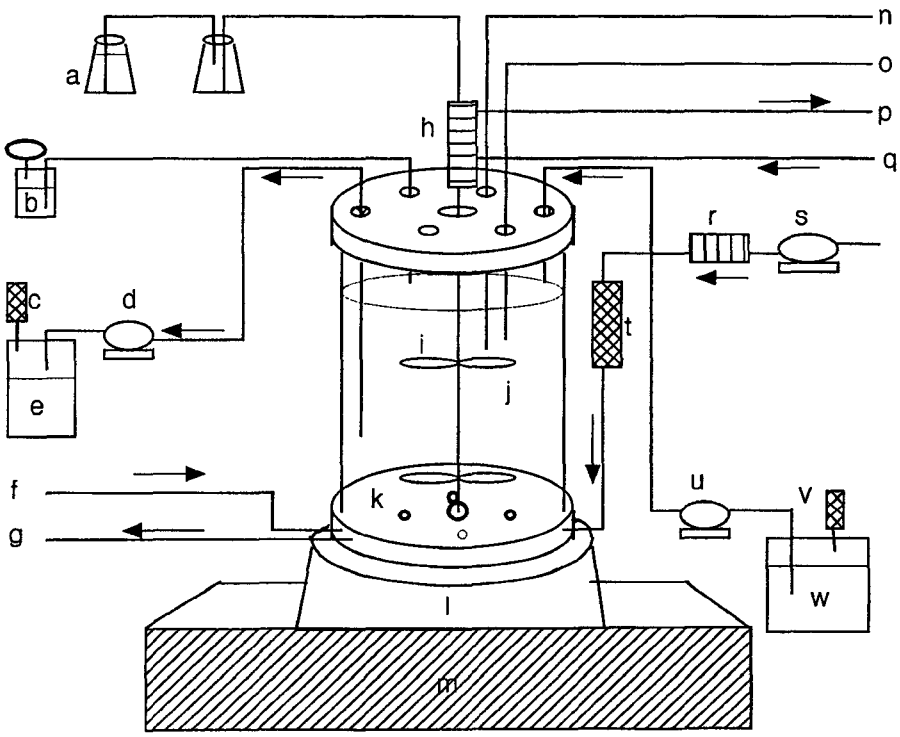

Fig. 1. Apparatus of continuous-type bioreactor.

a. Ethanol
b. Antiform
c,t,v. Air filter
d,u. Peristaltic pump
e. Effluent sample vessel
f,q. Water in
g,p. Water out
h. Condensor
i. Propeller
j. Bio-reactor vessel
k. Air inlet port
l. Heater
m. Motor
n. Thermometer
o. pH meter
r. Air flowmeter
s. Air compressor
w. Substrate vessel

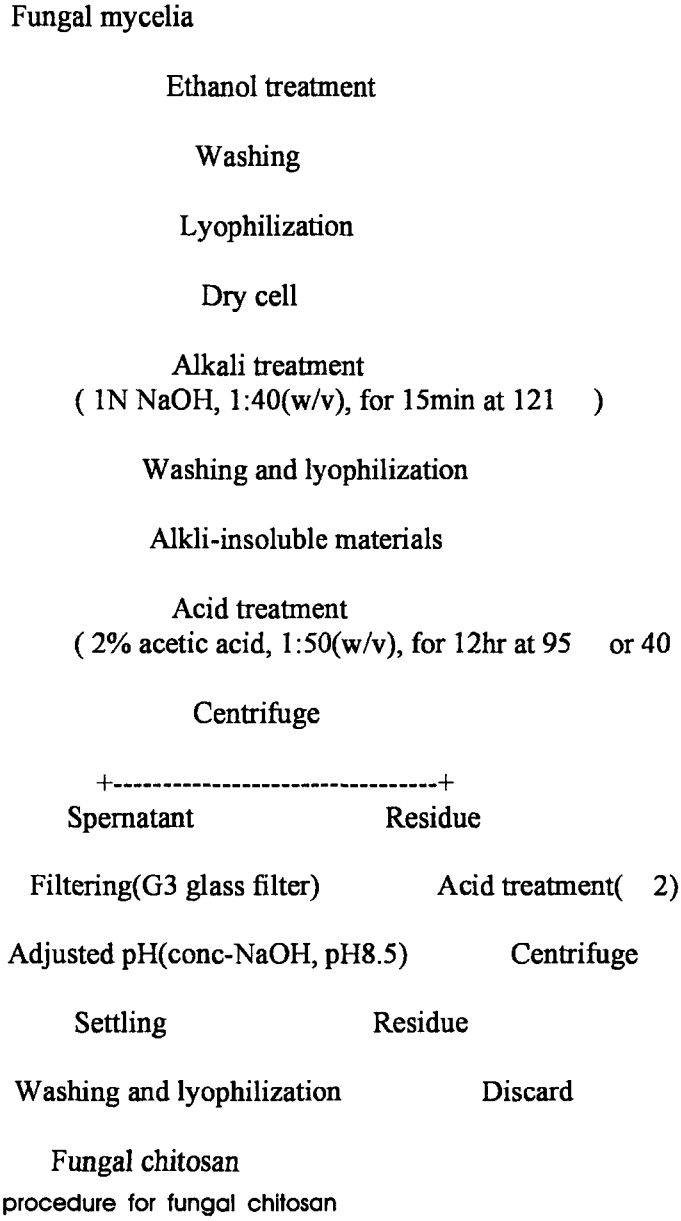

Fig. 2. Extraction procedure for fungal chitosan

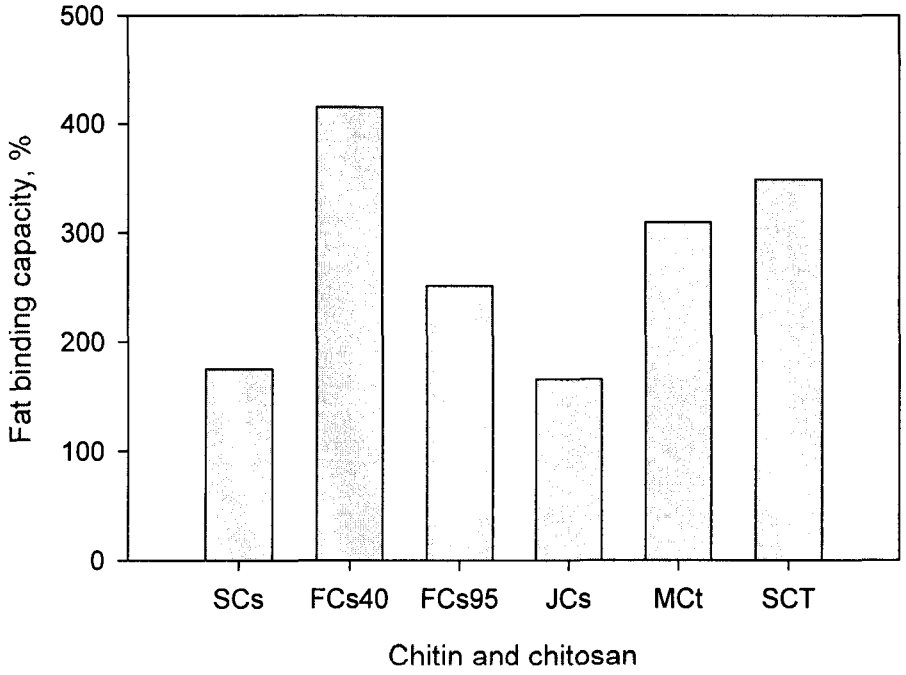

Fig. 3. Fat binding capacity of chitin and chitosan

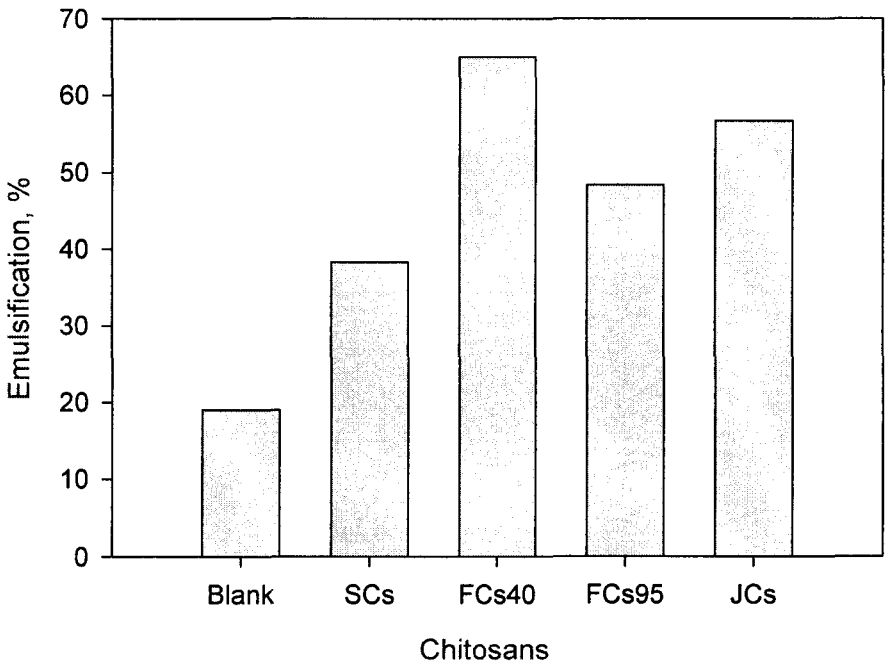

Fig. 4. Emulsification of chitosan.

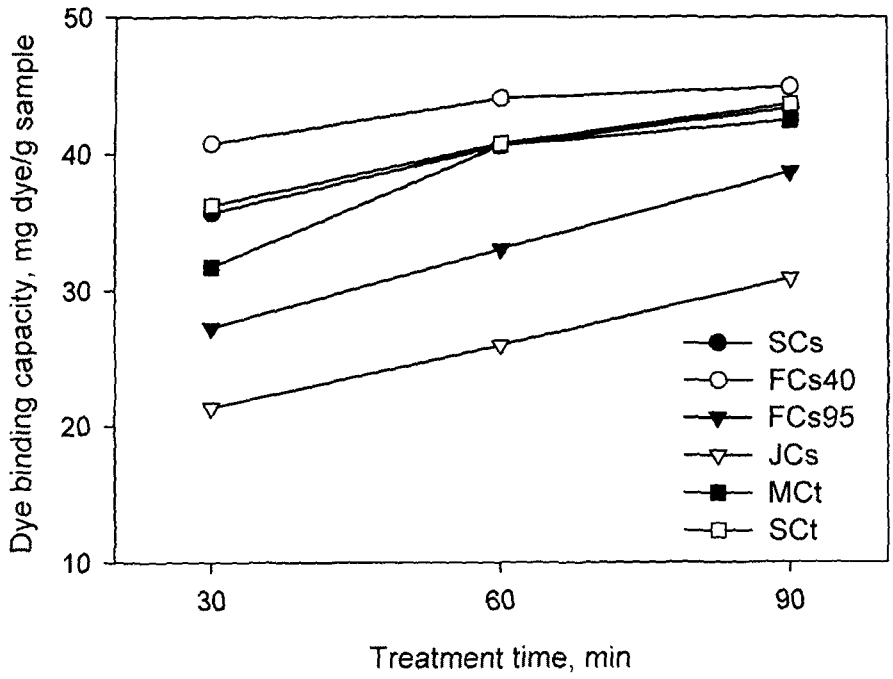

Fig. 5. Dye vinding capacity of chitin and chitosan by treatment time with dye soluton.