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Determination of the effective components in the various parts of *Luffa cylindrica* (L.) Roemer and development to remove the flesh from its fruit : (II)

Removal of flesh on the net fiber in fruit of sponge-gourd and improvement of quality of the net fiber

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Abstrat : The skin and fleshy substance on the net fiber of sponge-gourd fruit pressed mechanically was removed with 0.2% NaOH solution in 3~5 hours. The treatment of 0.2% NaOH with 0.02% Monopol(non-ionogenic polyoxethylen derivative) as surfactnat and with 0.1% $Ca(OCl)_2$ as bleaching agent enhanced the effect to remove the fleshy substance and improve the quality of net fiber. Also, the wet hardness and tensile strength of net fiber were controlled by the crosslinkage of the fiber with glutardialdehyde, glyoxal, and formalin, respectively. The net fiber was stable on the acid and alkaline solutions. Also the range of temperature to degradate the fiber was 338~385℃. These values indicated a fair stability. The improved net fiber can be used for raw material of bath, dish washing, oil and gas filter, and many kinds of decorations(Received November 21, 1991, accepted December 23, 1991).

It takes around fifteen to twenty days to remove the skin and flesh on the net fiber of sponge-gourd fruit by soaking in natural stream. In this case, the operation is troublesome and working expenses are increased. Especially, the quality of the net fiber-colour, degree of removal of the flesh-can not be controlled.

For long time, a lot of researches were performed to confer the some properties to fiber materials for consumers. By Eschalier in 1906,[4] formaldehyde was used as a crosslinking agent and then glyoxal, dihalogen compounds, diisocyanate, diepoxy compounds, and divinylsulfone were proposed to produce wet strength and stabilization of fiber.[4,5,6,12,20) Crosslinked cellulose provides high wet strength with good absorbency and soft hand.[13]

Therefore, this research was focused on the removal of skin and flesh on the net fiber of sponge-gourd fruit in a short time and on the improvement of quality of the net fiber. The mechanization and standardization of the processes to remove the flesh on the net fiber are required for quality control.

Materials and Methods

Materials

The fruits of sponge-gound were produced in the field of Chungnam Provincial, RDA located in Tae-

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jon. The managements of cultivation were described in the previous report(1). The ripe fruits were harvested and used for the experiments to remove the skin and flesh on the net fiber of sponge-gourd fruit.

Methods

1) Effect of the Pressing and Alkaline Treatments on the Removal of the Skin and Flesh on the Net Fiber of Sponge-gourd

Eight levels from zero to 2% NaOH concentrations were used to remove the skin and flesh of the sponge-gourds pressed by mechanical method and non-pressed. The removal time of flesh from the sponge-gourd was determined and the quality of net fiber was evaluated by sensory test. Samples of superior levels which the flesh was removed in 3~5 hours, were selected and were evaluated by the examination of 1% NaOH extract, alcohol-benzene extract, tensile force, whiteness, and net fiber quality.

2) Effect of Surfactants and Bleaching Agents on the Removal of Flesh and Quality of Net Fiber of Sponge-gourd

Monopol as non-ionic surfactant, urea as swelling agent,[7,22] and H_2O_2 and $Ca(OCl)_2$ as bleaching agents were chosen for chemicals to improve the quality of net fiber. Fresh fruit of sponge-gourd were soaked in the solutions of 0.2% NaOH mixed with 0.02% Monopol, 0.1% urea, 0.1% H_2O_2, and 0.1% $Ca(OCl)_2$ respectively. Quality of the net fibers dried after treatment with the solutions were evaluated by the determination of 1% NaOH extract, alcohol-benzene extract, tnesile force, and whiteness.

3) Effect of Crosslinking Agents on the Quality of the Net Fiber of Sponge-gourd[12,19,20]

To improve the quality of the net fiber of sponge-gourd, two kinds of net fiber, which the flesh of sponge-gourd had been removed with natural water and 0.2% NaOH solution respectively, were treated by three chemicals, 25% glutardialdehyde, 40% glyoxal, and 37% formalin. Each crosslinking agent was made in 3 and 6% of above three chemicals. The treated samples were used to determine the rates of water absorption and desorption, and quality components.

4) Physical Characteristics of Net Fiber of Sponge-gourd[14,19]

(1) Moisture Absorbency and Desorbency of the Net Fiber of Sponge-gourd : Net fiber was soaked and moisture absorbency was determined by the weight at an interval of proper time for 24 hours. The same sample was dried at room temperature and humidity, and weighed to determine the moisture desorbency.

(2) Tensile Strength of Net Fiber of Sponge-gourd: The net fiber was cut 1 cm×3 cm large and the tensile strength was determined by holding 1cm of each end and pulling the fiber by Shimadzu AG S-500B Instron. For wet sample, the cut net fiber was determined after 24 hours of soaking in natural water.

5) Stability of the Net Fiber on the Acid, Alkaline,

Table 1. Effect of the pressing and concentration of NaOH on the removal of flesh from sponge-gourd fruit

Pretreatment	NaOH Conc. (%)	Removal time of flesh(hr)[a]	Net fiber quality[b]
Pressed	0	72-98	Good
〃	0.1	20~24	〃
〃	0.2	3~5	〃
〃	0.3	3~5	〃
〃	0.4	2~4	〃
〃	0.5	2~4	〃
〃	1	1~3	〃
〃	2	1~2	〃
Non-pressed	0	>168	〃
〃	0.1	72~96	〃
〃	0.2	48~72	〃
〃	0.3	48~72	〃
〃	0.4	30~36	〃
〃	0.5	30~36	〃
〃	1	18~24	〃
〃	2	12~18	〃

[a] Average of five times from October to November in 1990.

[b] Evaluated with the net fiber extracted by natural water.

and Thermal Treatments[20]

0.05g of net fiber was placed in a beaker with 100ml treating solution and washed with water after stirring for two hours. The sample was weighed after drying at 105℃ for 24 hours in a dry oven. Treating concentrations of acid were 70, 80 and 95% H_2SO_4, and 10, 20, 30% of NaOH were used as alkaline treatments. The thermal stability was determined through thermogravimetric analysis (TGA) and differential scanning calorimeter(DSC) by using General V4. IC Dupont 2100.

Results and Discussion

Pressed and non-pressed sponge-gourd fruits were soaked in the alkaline solutions : 0, 0.1, 0.2, 0.3, 0.4, 0.5, 1.0, and 2.0% concentrations respectively. The effect of pressing was drastic and alkaline treatments affected the removal of the skin and flesh of the net fiber in sponge-gourd significantly. In the pressed sponge-gourd, 0.2% NaOH treatment was the best condition to remove the flesh of sponge-gourd in 3~5 hours, compared to 72~98 hours in the treatment of natural water(Table 1).

Among the pressed samples, four levels of the NaOH concentration were selected and the qualities were evaluated by determination of 1% NaOH extract, alcohol-benzene extract, and whiteness. The amounts of 1% NaOH and alcohol-benzene extract in the treatment of 0.3% NaOH were lower than one of the 0.2% NaOH(Table 2).

To lower the concentration of NaOH and to improve the fiber quality, 0.2% alkaline treatment was focused on further research. In Table 3, two treatments of 0.2% NaOH with 0.02% Monopol as surfactant and with 0.1% $Ca(OCl)_2$ as bleaching agent were evaluated as good effects.

To conform if three to five hours are proper time

Table 2. Effect of the concentration of NaOH on the quality of dry net fiber of pressed sponge-gourd

NaOH Conc. (%)	Removal time of flesh(hr.)	1% NaOH extract(%)	Alc-Ben extract(%)	Tensile strength(kgf)	Whiteness (%)	Net fiber quality
0.0	72~98	17.0	19.5	10.5	31.4	Good
0.2	3~5	11.7	10.0	10.0	34.5	Good
0.3	3~5	9.3	9.1	9.1	36.7	Good
0.5	2~4	9.8	11.1	11.6	34.5	Good

Table 3. Effect of the composition of extracting solution on the removal of the flesh from sponge-gourd fruit

Treatment	Removal time of flesh[a](hr.)	1% NaOH extract(%)	Alc-Ben extract(%)	Tensile strength(kgf)	Whiteness (%)	Net fiber quality[b]
0	72~98	17.0	19.5	10.5	31.4	Good
0.2% NaOH	3~5	12.7	10.0	10.0	34.5	Good
0.2% NaOH+ 0.02% Monopol	3~4	10.0	8.4	10.0	33.0	Good
0.2% NaOH+ 0.1% Urea	4~8	10.6	8.9	7.6	35.0	Good
0.2% NaOH+ 0.1% H_2O_2	3~4	11.6	11.1	11.8	37.5	Good
0.2% NaOH+ 0.1% $Ca(OCl)_2$	3~4	7.8	8.9	8.2	40.1	Good

[a] Average of three times from October to November in 1990.
[b] Evaluated with the net fiber extracted by natural water.

to remove the flesh from the net fiber by 0.2% NaOH, pressed sponge-gourds were extracted for 3∼5 and 20∼24 hours respectively. The contents of 1% NaOH and alcohol-benzene extracts were similar between two kinds of extracting time. It means that 3∼5 hours to extract the flesh are enough(Table 4).

In the experiment to improve the wet-hardness of net fiber with three chemicals-25% glutardialdehyde, 40% glyoxal, and 37% formalin, the net fiber treated with crosslinking agents showed the lower rate of water absorption and desorption in 3 and 6% of the agents than control. Also the values of the rate of water absorption and desorption were lower in the treatments of alkaline solution than those of natural water. It is explained that the crosslinked cellulose is formed by the reaction of cellulose-OH and aldehyde, that is, $2Cell\text{-}OH + CH_2O = Cell\text{-}OCH_2O\text{-}Cell$.[5,12,20)]

In Table 6, the tensile strength of the fiber treated with 0.2% NaOH was similar to the fiber treated with natural water. Also the treatments showed

Table 4. Comparison of the time to remove flesh on the net fiber with 0.2% NaOH solution

No.	Extracting solution	Soaking time of fruit(hr.)	1% NaOH extract(%)	Alc-Ben extract(%)	Whiteness (%)
1	Control	72∼98	17.0	19.5	33.1
2	0.2% NaOH	20∼24	14.7	10.5	34.0
3	0.2% NaOH	3∼5	15.7	10.0	35.2

Table 5. Effect of crosslinking agents on the water absorption and desorption rate of net fiber of sponge-gourd

Removal agents of flesh	Agents[a)] / Conc.[b)]		Water absorption rate(%)					Water desorption rate(%)				
			5[c)]	10	60	360	1440	5[c)]	10	60	360	1440
Natural water	Glutardi-aldehyde/	0	208.2	243.8	343.0	367.5	367.8	5.2	9.3	17.1	52.9	77.8
		3	162.6	210.8	283.0	316.9	343.4	4.1	7.7	18.6	51.3	78.8
		6	158.7	196.3	238.2	272.4	309.7	2.6	6.6	14.7	49.3	76.8
	Glyoxal/	0	146.8	172.0	219.3	238.8	243.8	1.3	3.5	10.1	37.9	70.5
		3	101.9	143.4	167.3	189.6	206.9	1.4	3.4	8.8	35.7	66.2
		6	102.7	121.5	156.3	177.8	192.7	1.6	3.4	9.2	38.3	65.7
	Formalin/	0	153.5	189.7	222.2	235.8	246.4	0.8	3.5	8.8	40.1	70.8
		3	120.4	140.7	172.9	197.1	206.7	1.7	4.3	10.3	58.5	78.1
		6	109.9	138.9	165.2	191.3	200.0	2.0	3.4	7.4	38.3	67.1
0.2% NaOH	Glutardi-aldehyde/	0	146.9	185.3	222.0	250.7	265.1	1.0	3.0	10.6	36.9	72.4
		3	106.1	142.2	166.9	208.8	222.6	1.1	3.0	8.0	30.5	65.8
		6	103.4	125.1	165.7	194.1	202.5	0.3	2.7	11.1	32.8	66.4
	Glyoxal/	0	188.8	218.8	284.7	326.8	339.8	1.6	4.6	10.0	29.9	71.3
		3	134.4	141.9	199.3	251.1	273.1	0.5	2.0	5.7	27.5	67.6
		6	112.8	146.0	190.6	256.7	269.7	1.1	2.7	8.6	32.7	72.1
	Formalin/	0	133.5	152.9	211.0	218.1	219.5	5.4	8.4	13.8	35.9	68.1
		3	115.8	122.6	157.9	183.4	188.4	0.9	2.1	6.6	29.4	63.6
		6	72.1	111.5	162.8	194.1	202.0	1.3	2.6	8.6	34.9	67.1

[a)] : Crosslinking agents, [b)] : Concentrations of used chemicals, [c)] : Minutes

Table 6. Comparison of tensile strength of the net fiber treated with crosslinking agents after removal of flesh by natural water and 0.2% NaOH respectively

Removal agents of flesh	Crosslinking agents	Chemical Conc. (%)	Tensile strength(kgf)				Whiteness (%)
			Dry net fiber		Wet net fiber		
			A	B	A	B	
Naturtal water	Glutardi-aldehyde	0	16.6	2.8	8.9	2.3	34.2
		3	18.0	4.4	16.3	4.5	36.3
		6	24.0	3.4	21.1	5.2	37.3
	Glyoxal	0	32.0	7.3	20.1	4.6	30.0
		3	34.0	9.2	23.1	7.2	35.4
		6	35.8	8.4	24.9	8.2	37.6
	Formalin	0	14.8	7.4	16.1	7.3	34.2
		3	24.8	7.0	18.9	7.9	36.3
		6	23.0	7.5	17.1	9.1	35.2
0.2% NaOH	Glutard-aldehyde	0	11.0	2.8	9.6	3.1	34.4
		3	11.9	4.1	11.0	6.0	35.5
		6	25.5	2.3	15.3	4.8	35.2
	Glyoxal	0	22.4	6.1	23.6	5.1	34.2
		3	22.7	8.9	24.5	5.0	36.5
		6	24.3	6.5	24.2	6.2	36.2
	Formalin	0	8.2	2.1	9.7	2.3	35.0
		3	11.2	2.6	12.1	2.6	35.2
		6	9.2	2.2	11.6	2.4	37.0

A : Perpendicular direction, B : Horizontal direction.

Table 7. Stability of the net fiber on the acid and alkali

Acid-Alkali	Concentration (%)	Rate of loss in weight(%)	Remarks
H_2SO_4	70	17	Blackish
	80	29	
	100	67	
NaOH	10	0	Light yellow
	20	0	
	30	0	

a tendency to increase the tensile strengths of the net fiber according to the higher concentration of the agents. The tensile strength was generally stronger in perpendicular than horizontal direction in dry and wet conditions respectively.

The stability of the net fiber on the acid and alkaline solutions was considerable. Therefore, the concentration of 0.2% NaOH used as treating agent should not bring up any problem in the view of the quality of the net fiber.

Other methods to lower the concentration of NaOH by increasing the temperature of extract solution are being devised for removal of the flesh. Also, NaOH should be replaced as KOH, whose sludge can be used to fertilizers.

It was found that thermal degradation of net fiber started at 338℃ and ended at 385℃ by thermogravimetric analysis. These values indicated a fair stability to compare with the rate temperature to degrade a cotton cellulose, 337～384℃.

The composition of net fiber was found that the portion of α-cellulose was 76.2% in 89.2% of holocellulose, the content of lignin was 13～14%, and

20～40% was alcohol-benzene soluble components. Even though the physical and chemical structures of the net fiber were points of interest in researching the properties of sponge-gourd, they were not determined yet exactly.

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수세미외의 部位別 有效成分 調査 및 絲瓜絡中 肉質除去 方法 開發 硏究：(II) 사과락 육질제거 및 섬유품질개선

유태방・장기운*・안병창**・신종순・박종상*(한국조폐공사기술연구소, *충남대학교 농화학과, **충남농촌진흥원)

초록：일반 농가에서 수세미 사과락의 표피 및 그물섬유중 육질 제거를 위하여 개천수에 침지하여 20여일 소요되는데 비하여, 사과락을 압착한 후 0.2% NaOH로 처리한 결과 3～5 시간내에 처리가 가능하였다. 0.2% 알카리 용액과 계면활성제인 0.02% Monopol과 표백제인 0.1% $Ca(OCl)_2$를 처리하여 섬유소의 품질을 보호하면서 육질제거효과를 기할 수 있었다. 또한, 사용 목적에 따라 습경성과 인장강도와 같은 물리성을 formaldehyde, glutardialdehyde, glyoxal과 같은 가교제를 사용하여 조절할 수 있는 가능성을 나타냈다. 또한 산알카리 및 열적 안정도가 양호하여 목욕용 기구, 주방용 세척기구, 오일이나 까스 여과기, 기타 각종 장식용 제조 원료로 사용가능하다는 결론을 얻었다. NaOH 용액의 농도 저하와 KOH로 대치할 때 생성되는 스럿지를 K질 비료로 활용하는 방안 등이 연구중이다.