

Physicochemical Characterization of Extruded *Angelica gigas* Nakai Depending on the Extrusion Processing Parameter

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Objectives

The objectives of this study were as follows; (1)to characterize physicochemical properties of *Angelica gigas* Nakai extrudate depending on the extrusion processing parameter (2)to investigate the optimum condition of extrusion processing to increase extract yield and contents of functional ingredients obtained from *Angelica gigas* Nakai.

Materials and methods

○ Materials : *Angelica gigas* Nakai(Gangwon Jinbu, 2009), root

○ Methods

- Extrusion conditions

: twin-screw extruder, die 3mm(orifice), barrel heating 150°C

- Extrusion process parameter

: screw speed(40~80rpm), feeding rate(30~40kg/h), water(3.0~6.0kg/h)

- Physicochemical properties

: yield, water solubility index(WSI), water absorption index(WAI)

- Analysis of functional ingredients

: polyphenol, flavonoids, decursin and decursinol angelate

Results

The specific mechanical energy increased with increasing screw speed and decreasing water feed rate, due to decreasing flowability of sample in extruder screw. The structural modifications of *Angelica gigas* Nakai during extrusion processing could be responsible for increasing extract yield to 21.75%, WSI to 15.26% and contents of functional ingredients to 17.42% against non-extruded *Angelica gigas* Nakai. As the result of statistical analysis of response surface methodology(RSM), the maximum extract contents of decursin and decursinol angelate was obtained when speed screw was 88.48rpm, feed rate 33.97kg/h, water feed rate 4.5kg/h.

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Table 1. Extrusion condition for *Angelica gigas* Nakai

Experiment No.	Torque (%)	Screw speed (rpm)	Sample feed (kg/h)	Water (kg/h)	Pressure (bar)	Raw sample ¹ M.C (%)	Dough M.C (%)	² E.T (°C)	³ SME (KJ/kg)
1	58.5	40	40	4.5	17.5	1.1	11.1	139.0	197.7
2	44.5	40	35	6.0	17	1.1	15.6	138.5	163.2
3	32.5	60	30	6.0	17	1.1	17.6	139.5	203.7
4	68.5	40	40	3.0	18	1.1	8.0	143.0	239.6
5	40.5	60	40	6.0	18	1.1	14.0	146.0	198.6
6	31.0	80	30	4.5	18	1.1	14.0	146.0	270.3
7	38.5	40	30	4.5	17	1.1	14.0	140.0	167.8
8	34.5	80	35	6.0	18	1.1	15.6	145.0	253.1
9	39.0	60	35	4.5	18	1.1	12.4	145.0	222.7
10	46.0	40	35	4.5	17.5	1.1	12.4	141.5	175.1
11	37.5	80	40	4.5	18.5	1.1	11.1	151.0	253.5
12	30.5	80	30	6.0	18	1.1	17.6	146.5	254.8
13	34.5	80	35	3.0	18.5	1.1	8.9	152.5	273.1
14	50.5	60	40	3.0	18.5	1.1	8.0	156.5	264.9
15	37.5	80	40	6.0	18	1.1	14	146.5	245.2

¹M.C : Moisture contents, ²E.T: Extrusion temperature, ³SME: Specific mechanical energy

Table 2. Physicochemical property and contents of functional ingredients from extruded *Angelica gigas* Nakai

Sample	Yield (%)	¹ WSI(%)	² WAI(mL/g)	Total carbohydrate (%)	Total polyphenol (%)	Total flavonoids (%)	Decursin+ Decursinol Angelate (%)
³ NEA	44.40±1.55 ϵ	63.43±2.21 c	10.42±1.22 a	29.65±1.45 ϵ	0.63±0.01 h	0.46±0.00 ϵ	5.31±0.03 f
1	48.77±0.33 ϵ	68.20±0.46 abc	8.39±0.08 cd	36.37±2.61 de	0.93±0.01 e	0.72±0.00 e	5.79±0.15 cd
2	54.23±1.64 bc	74.85±12.92 a	8.00±0.13 def	38.83±0.88 abc	0.95±0.01 d	0.78±0.00 bcd	5.98±0.55 bc
3	54.07±1.44 bc	69.33±1.84 abs	8.22±0.13 de	38.54±1.35 $abcd$	0.95±0.01 d	0.78±0.01 bcd	6.37±0.12 a
4	56.74±1.13 a	72.28±1.44 ab	9.00±0.25 b	36.70±0.32 cde	0.77±0.01 ϵ	0.67±0.01 f	5.57±0.17 e
5	53.99±0.44 bc	67.49±0.55 abc	7.82±0.15 ef	40.70±1.39 a	0.98±0.03 cd	0.80±0.00 a	6.25±0.12 a
6	54.39±1.48 b	67.56±1.84 abc	7.74±0.19 ef	32.91±1.15 f	0.85±0.01 f	0.67±0.00 f	6.43±0.06 a
7	53.40±0.80 bcd	67.17±1.00 abc	7.80±0.12 ef	40.66±0.52 a	0.97±0.01 cd	0.77±0.01 cd	6.32±0.11 a
8	54.40±0.12 b	69.29±0.15 abc	8.12±0.19 de	39.18±1.81 ab	1.02±0.02 b	0.79±0.01 abc	6.33±0.07 a
9	52.41±0.22 d	65.51±0.27 bc	8.43±0.09 cd	37.72±2.06 $bcde$	0.97±0.02 cd	0.77±0.02 d	5.92±0.17 bc
10	52.43±0.15 d	66.37±0.19 bc	8.83±0.27 bc	38.93±0.37 abc	1.02±0.00 b	0.79±0.01 ab	6.02±0.15 b
11	53.97±1.07 bc	67.47±1.33 abc	7.96±0.53 def	36.08±1.10 e	0.90±0.03 e	0.68±0.00 f	5.70±0.17 de
12	53.50±0.24 bcd	67.72±0.31 abc	8.08±0.24 de	35.90±1.09 e	1.00±0.03 c	0.68±0.01 f	6.31±0.10 a
13	52.56±0.62 d	65.70±0.77 bc	7.81±0.11 ef	37.20±1.90 $bcde$	1.03±0.02 b	0.72±0.01 e	5.53±0.07 e
14	52.94±0.59 bc	65.36±0.72 bc	7.51±0.14 f	37.25±2.01 $bcde$	1.10±0.00 a	0.73±0.01 e	5.69±0.15 de
15	53.95±0.30 a	67.02±0.37 abc	7.97±0.30 def	38.48±0.22 $bcde$	1.01±0.00 b	0.79±0.01 abc	6.00±0.26 b
⁴ GCA	46.44±1.04 f	62.89±5.96 c	5.75±0.13 ϵ	25.46±2.01 h	0.53±0.01 i	0.39±0.00 h	

¹WSI: Water solubility index, ²WAI: Water absorption index, ³NEA: Non-extruded *Angelica gigas* Nakai,

⁴GCA : General cutting *Angelica gigas* Nakai