

Supplementary Table Materials

Staged Temperature- and Humidity-Controlled Combined Infrared Hot-Air Drying (TH-IRHAD) of Sea Buckthorn Reduces Drying Time, Energy Consumption, and Browning

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Supplementary Table S1 Factors and levels of response surface test in first-drying stages

Factor	Level		
	-1	0	1
Drying Temperature A / °C	60	70	80
Medium Relative Humidity B / %	10	25	40
High Medium Relative Humidity duration C / min	20	40	60

Supplementary Table S2 Optimal solution set in first-drying stages

No.	Dryin g tempe rature/ °C	relativ e humid ity/%	Time/m in	DT/min	SEC/ kW·h ·kg ⁻¹	NEB/A bs·g ⁻¹ DW	<i>L</i> *	<i>Rr</i> /g· g ⁻¹	Vc/%	TFC/mg RE·g ⁻¹ DW	TPC/mg GAE·g ⁻¹ DW	value of expe ctatio n
1	80.000	28.413	59.851	495.472	4.297	0.825	37.010	1.650	24.40	15.908	9.773	0.685
2	80.000	28.259	59.569	495.886	4.305	0.822	37.055	1.650	24.50	15.928	9.753	0.685
3	80.000	27.714	58.684	497.195	4.330	0.814	37.195	1.650	24.70	15.994	9.690	0.685
4	80.000	29.174	61.106	493.495	4.258	0.839	36.800	1.650	24.10	15.806	9.870	0.685
5	80.000	29.310	61.329	493.129	4.250	0.841	36.762	1.650	24.00	15.787	9.888	0.685
6	80.000	29.491	61.625	492.637	4.240	0.845	36.710	1.650	24.00	15.761	9.912	0.684
7	80.000	26.965	57.416	498.944	4.364	0.802	37.384	1.650	24.90	16.078	9.605	0.684
8	80.000	29.715	61.988	492.024	4.228	0.849	36.646	1.650	23.90	15.729	9.943	0.684
9	80.000	29.717	59.689	494.444	4.270	0.813	37.015	1.659	24.10	15.851	9.765	0.684
10	80.000	29.842	62.192	491.673	4.221	0.851	36.609	1.650	23.80	15.710	9.960	0.683
11	80.000	30.208	60.312	493.266	4.246	0.819	36.909	1.660	23.90	15.795	9.816	0.683
12	80.000	30.489	61.718	491.466	4.213	0.839	36.676	1.656	23.70	15.704	9.928	0.683
13	80.000	26.498	56.618	499.980	4.384	0.795	37.498	1.650	25.10	16.126	9.556	0.683
14	79.845	28.809	60.370	495.957	4.303	0.827	36.980	1.650	24.20	15.872	9.808	0.683
15	80.000	26.342	56.350	500.318	4.390	0.793	37.535	1.650	25.10	16.141	9.539	0.682
16	79.776	28.225	59.347	498.085	4.344	0.815	37.170	1.650	24.50	15.955	9.730	0.681
17	80.000	32.687	58.499	491.643	4.200	0.774	37.130	1.682	23.50	15.730	9.712	0.681
18	80.000	32.005	60.409	490.816	4.190	0.807	36.855	1.671	23.50	15.689	9.846	0.681
19	80.000	32.943	58.845	490.882	4.185	0.777	37.072	1.682	23.50	15.700	9.743	0.680
20	80.000	25.835	56.857	500.000	4.388	0.803	37.469	1.644	25.20	16.145	9.580	0.679

Supplementary Table S3 The results in first-drying stages optimum test were verified

Index	DT/min	$SEC/\text{kW}\cdot\text{h}\cdot\text{kg}^{-1}$	$NEB/\text{Abs}\cdot\text{g}^{-1}\text{DW}$	L	$Rr/\text{g}\cdot\text{g}^{-1}$	$Vc/\%$	$TFC/\text{mg RE}\cdot\text{g}^{-1}\text{DW}$	$TPC/\text{mg GAE}\cdot\text{g}^{-1}\text{DW}$
Predicted Value	495.59	4.30	0.82	37.02	1.65	24.00	15.91	9.77
Trial Value	500.00	4.32	0.79	38.24	1.67	23.00	16.51	10.04
Relative Error/%	0.89	0.47	3.66	3.30	1.21	4.17	3.77	2.76

Supplementary Table S4 Factors and levels of response surface test in second-drying stages

Factor	Level		
	-1	0	1
Drying Temperature A / °C	60	70	80
Medium Relative Humidity B / %	10	25	40
High Moisture Retention Time C / min	10	65	120

Supplementary Table S5 Optimal solution set in second-drying stages

N o.	Dryin g tempe rature/ °C	relativ e humid ity/%	Time/m in	DT/min	SEC/ kW·h ·kg ⁻¹	NEB/A bs·g ⁻¹ DW	<i>L</i> *	<i>Rr</i> /g· g ⁻¹	Vc/%	<i>TFC</i> /mg RE·g ⁻¹ DW	<i>TPC</i> /mg GAE·g ⁻¹ DW	value of expe ctatio n
1	78.315	16.601	84.307	466.735	4.350	0.431	39.777	1.658	21.40	15.847	11.040	0.458
2	78.320	16.631	84.716	466.640	4.350	0.431	39.776	1.658	21.40	15.848	11.028	0.458
3	78.302	16.554	83.799	466.901	4.350	0.431	39.779	1.658	21.40	15.848	11.051	0.458
4	78.309	16.569	83.895	466.835	4.350	0.431	39.778	1.658	21.40	15.846	11.050	0.458
5	78.291	16.517	83.408	467.038	4.350	0.431	39.780	1.657	21.40	15.849	11.059	0.458
6	78.342	16.685	85.045	466.434	4.350	0.431	39.773	1.658	21.40	15.843	11.027	0.458
7	78.289	16.493	82.957	467.115	4.350	0.431	39.780	1.657	21.40	15.847	11.073	0.458
8	78.345	16.756	86.120	466.273	4.350	0.431	39.773	1.659	21.50	15.849	10.994	0.458
9	78.321	16.708	85.948	466.470	4.350	0.430	39.776	1.659	21.40	15.855	10.990	0.458
10	78.388	17.018	88.762	465.611	4.350	0.431	39.765	1.661	21.50	15.851	10.934	0.458
11	78.135	15.983	76.231	469.057	4.347	0.433	39.791	1.652	21.20	15.851	11.234	0.458
12	78.491	17.652	93.941	464.201	4.350	0.433	39.741	1.664	21.70	15.849	10.830	0.458
13	78.457	17.937	96.867	464.190	4.350	0.432	39.736	1.666	21.80	15.875	10.744	0.458
14	78.681	19.075	103.392	461.517	4.350	0.443	39.676	1.669	22.20	15.845	10.653	0.457
15	76.541	13.899	43.010	479.387	4.252	0.450	39.787	1.626	21.20	16.046	11.709	0.442
16	60.000	19.313	10.000	478.584	4.250	0.418	39.966	1.724	20.90	17.034	9.752	0.434
17	60.000	19.195	10.929	479.794	4.269	0.414	39.988	1.725	20.80	17.084	9.759	0.433
18	72.710	14.100	10.000	486.433	4.007	0.469	39.690	1.613	22.50	16.479	11.490	0.427
19	72.834	14.092	10.506	486.352	4.011	0.470	39.689	1.612	22.50	16.464	11.518	0.427
20	72.174	13.616	10.000	487.420	4.023	0.455	39.740	1.614	22.40	16.617	11.220	0.427

Supplementary Table S6 The results in second-drying stages optimum test were verified

Index	<i>DT</i> /min	<i>SEC</i> /kW·h ·kg ⁻¹	<i>NEB</i> /Abs ·g ⁻¹ DW	<i>L</i>	<i>Rr</i> /g·g ⁻¹	<i>Vc</i> /%	<i>TFC</i> /mg RE·g ⁻¹ DW	<i>TPC</i> /mg GAE·g ⁻¹ DW
Predicted Value	466.78	4.35	0.43	39.78	1.66	21.00	15.85	11.04
Trial Value	455.00	4.15	0.41	40.69	1.69	22.00	16.62	10.49
Relative Error/%	2.52	4.60	4.65	2.29	1.81	4.76	4.86	4.98

Supplementary Table S7 Experimental design and related parameters in third-drying stages

Technological parameter	No.	Level	Time quantum
First-drying stage: 80°C-28%-60 min	1	60°C	Finish
Second-drying stage: 78°C-17%-84 min	2	65°C	Finish
Third-drying stage: Humidification off, set	3	70°C	Finish
the moisture removal value of 10%, different	4	75°C	Finish
drying temperature	5	80°C	Finish

Supplementary Table S8 D_{eff} in the drying process of sea buckthorn at different temperatures

No.	Drying Process	$D_{eff}/\text{m}^2\cdot\text{s}^{-1}$	DT/min
1	60°C-10%	$1.47\times 10^{-8}\text{ }^{\text{d}}$	1026 ^{c}
2	65°C-10%	$1.56\times 10^{-8}\text{ }^{\text{c}}$	753 ^{d}
3	70°C-10%	$1.84\times 10^{-8}\text{ }^{\text{b}}$	577 ^{c}
4	75°C-10%	$1.89\times 10^{-8}\text{ }^{\text{b}}$	455 ^{b}
5	80°C-10%	$2.04\times 10^{-8}\text{ }^{\text{a}}$	363 ^{a}

Note: Different letters indicate significant differences in samples ($p < 0.05$)

Supplementary Table S9 Normalized results and comprehensive scores of index parameters at different drying temperatures

No.	Drying Process	<i>DT</i>	<i>SEC</i>	<i>Rr</i>	<i>L*</i>	<i>NEB</i>	Vc Retention Rate	<i>TFV</i>	<i>TPC</i>	Comprehensive Evaluation
1	60°C-10%	0	0	0	0.25	0.53	0	1.00	1.00	0.38
2	65°C-10%	0.41	0.41	0.71	0.75	0.87	0.20	0.59	0.67	0.57
3	70°C-10%	0.68	0.66	1.00	1.00	1.00	0.60	0.50	0.22	0.67
4	75°C-10%	0.86	0.84	0.34	0.34	0.47	0.80	0.19	0.11	0.50
5	80°C-10%	1.00	1.00	0	0	0	1.00	0	0	0.40

Supplementary Table S10 Quality analysis of sea buckthorn under different drying methods

Drying Process	<i>DT</i> /min	<i>SEC</i> /kW·h·kg ⁻¹	<i>NEB</i> /Abs·g ⁻¹ DW	<i>L</i> *	<i>Rr</i> /g·g ⁻¹	<i>Vc</i> /%	<i>TFC</i> /mg RE·g ⁻¹ DW	<i>TPC</i> /mg GAE·g ⁻¹ DW
Three-stage temperature control and humidity control								
70°C-10%	577 ±8.21 ^b	4.67 ±0.05 ^c	0.33 ±0.02 ^b	41.90 ±0.12 ^a	1.79 ±0.01 ^a	21.24 ±0.54 ^c	18.76 ±0.12 ^a	10.83 ±0.21 ^a
Dry at constant temperature and humidity								
75°C-10%	880 ±9.24 ^a	7.33 ±0.06 ^a	0.42 ±0.01 ^a	38.46 ±0.09 ^c	1.53 ±0.01 ^c	28.32 ±0.94 ^b	15.56 ±0.09 ^b	8.44 ±0.18 ^b
Dry at constant temperature and humidity								
	580 ±7.84 ^b	5.64 ±0.18 ^b	0.26 ±0.02 ^c	39.28 ±0.09 ^b	1.69 ±0.01 ^b	31.94 ±1.20 ^a	13.13 ±0.10 ^c	7.06 ±0.13 ^c

Note: Different letters indicate significant differences in samples ($p < 0.05$)