



Enhance the Bioactivity of Royal Jelly via High Hydrostatic Pressure

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ABSTRACT

Royal jelly has been proven to have multiple benefits, such as enhancing immunity, promoting tissue regeneration, protecting cardiovascular health, and having anti-aging effects. It contains antioxidants like phenols and flavonoids, which can provide antioxidant effects, delay aging, reduce inflammation, accelerate wound healing, inhibit bacteria, and control blood sugar levels. High pressure processing (HPP) is an advanced food processing method that treats food by placing it in a high-pressure environment. In this process, food is submerged in water and subjected to pressures ranging from thousands to hundreds of thousands of pounds per square inch. This high-pressure treatment significantly reduces the number of microorganisms in the food, thereby extending its shelf life. Additionally, the pressure can alter the activity of enzymes in the food, making it more suitable for specific uses or processes. High pressure can also cause starch gelatinization and protein denaturation, changing the texture and taste of the food. This study investigates whether the beneficial components of royal jelly, such as total phenols, flavonoids, and antioxidant capacity, are enhanced after being treated with HPP. The study also analyzes the characteristics of royal jelly from different pollen sources after various pressure durations, comparing their differences. The results show that HPP increases the content of 10-HDA (10-hydroxy-2-decenoic acid) and total phenolic flavonoids in royal jelly. After HPP treatment, the antibacterial ability of royal jelly is significantly enhanced, and it effectively kills cancer cells, reducing their survival rate.

MATERIALS AND METHODS

Preparation of different floral source Royal Jelly Samples
Include maize, rape, tea blossom (*Camellia sinensis*) and Roxburgh Sumac.

Royal jelly samples were treated with different High-Pressure Processing (100, 300 and 600 MPa) for different times (5, 10 and 20 min).

Physical and Chemical analysis of acidic, 10-HDA, total phenols and flavonoids.

Bioactivity analysis of antioxidant, anti-bacterial and cancer cell survival rate

RESULTS

Physical and Chemical analysis

Table 1. The acidic of royal jelly treat with different HPP conditions

Pressure	Times	10-HDA (mg/g)	10-HDA (%)	10-HDA (mg/g)	10-HDA (%)
100MPa	5min	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*
	10min	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*
	20min	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*
300MPa	5min	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*
	10min	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*
	20min	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*
600MPa	5min	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*
	10min	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*
	20min	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*	37.1215±0.45*

*Means in a column with different superscripts are significantly different ($p < 0.05$)

Table 2. The 10-HDA content of royal jelly treat with different HPP conditions

Pressure	Times	10-HDA (mg/g)	10-HDA (%)	10-HDA (mg/g)	10-HDA (%)
100MPa	5min	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*
	10min	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*
	20min	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*
300MPa	5min	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*
	10min	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*
	20min	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*
600MPa	5min	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*
	10min	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*
	20min	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*	1.7620±0.01*

*Means in a column with different superscripts are significantly different ($p < 0.05$)

Table 3. The total phenols content of royal jelly treat with different HPP conditions

Pressure	Times	Total Phenols (mg/g)	Total Phenols (%)	Total Phenols (mg/g)	Total Phenols (%)
100MPa	5min	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*
	10min	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*
	20min	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*
300MPa	5min	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*
	10min	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*
	20min	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*
600MPa	5min	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*
	10min	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*
	20min	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*	66.4121±0.13*

*Means in a column with different superscripts are significantly different ($p < 0.05$)

Table 4. The total flavonoids content of royal jelly treat with different HPP conditions

Pressure	Times	Total Flavonoids (mg/g)	Total Flavonoids (%)	Total Flavonoids (mg/g)	Total Flavonoids (%)
100MPa	5min	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*
	10min	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*
	20min	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*
300MPa	5min	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*
	10min	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*
	20min	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*
600MPa	5min	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*
	10min	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*
	20min	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*	4.4242±0.01*

*Means in a column with different superscripts are significantly different ($p < 0.05$)

RESULTS

Anti-bacterial activity

Table 8. The anti-bacterial activity of tea blossom royal jelly that treat with different HPP conditions

Pressure	Times	10-HDA (mg/g)	10-HDA (%)	10-HDA (mg/g)	10-HDA (%)
100MPa	5min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	10min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	20min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
300MPa	5min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	10min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	20min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
600MPa	5min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	10min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	20min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*

Table 9. The anti-bacterial activity of Roxburgh Sumac royal jelly that treat with different HPP conditions

Pressure	Times	10-HDA (mg/g)	10-HDA (%)	10-HDA (mg/g)	10-HDA (%)
100MPa	5min	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*
	10min	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*
	20min	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*
300MPa	5min	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*
	10min	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*
	20min	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*
600MPa	5min	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*
	10min	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*
	20min	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*	17.1732±0.01*

Table 10. The anti-bacterial activity of rape royal jelly that treat with different HPP conditions

Pressure	Times	10-HDA (mg/g)	10-HDA (%)	10-HDA (mg/g)	10-HDA (%)
100MPa	5min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	10min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	20min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
300MPa	5min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	10min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	20min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
600MPa	5min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	10min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	20min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*

Table 11. The anti-bacterial activity of maize royal jelly that treat with different HPP conditions

Pressure	Times	10-HDA (mg/g)	10-HDA (%)	10-HDA (mg/g)	10-HDA (%)
100MPa	5min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	10min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	20min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
300MPa	5min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	10min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	20min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
600MPa	5min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	10min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*
	20min	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*	14.8752±0.01*

RESULTS

Anti-oxidant activity

Table 5. DPPH radical-scavenging activity of royal jelly treat with different HPP conditions

Pressure	Times	10-HDA (mg/g)	10-HDA (%)	10-HDA (mg/g)	10-HDA (%)
100MPa	5min	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*
	10min	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*
	20min	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*
300MPa	5min	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*
	10min	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*
	20min	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*
600MPa	5min	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*
	10min	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*
	20min	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*	43.0121±0.13*

Table 6. Reducing power of royal jelly treat with different HPP conditions

Pressure	Times	10-HDA (mg/g)	10-HDA (%)	10-HDA (mg/g)	10-HDA (%)
100MPa	5min	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*
	10min	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*
	20min	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*
300MPa	5min	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*
	10min	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*
	20min	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*
600MPa	5min	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*
	10min	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*
	20min	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*	138.1215±0.45*

Table 7. FRAP of royal jelly treat with different HPP conditions

Pressure	Times	10-HDA (mg/g)	10-HDA (%)	10-HDA (mg/g)	10-HDA (%)
100MPa	5min	16.8752±0.01*	16.8752±0.01*	16.8752±0.01*	16.8752±0.01*
	10min	26.3126±0.01*	26.3126±0.01*	26.3126±0.01*	26.3126±0.01*
	20min	24.3126±0.01*	24.3126±0.01*	24.3126±0.01*	24.3126±0.01*
300MPa	5min	12.2262±0.01*	12.2262±0.01*	12.2262±0.01*	12.2262±0.01*
	10min	18.7512±0.01*	18.7512±0.01*	18.7512±0.01*	18.7512±0.01*
	20min	23.2512±0.01*	23.2512±0.01*	23.2512±0.01*	23.2512±0.01*
600MPa	5min	12.7512±0.01*	12.7512±0.01*	12.7512±0.01*	12.7512±0.01*
	10min	18.7512±0.01*	18.7512±0.01*	18.7512±0.01*	18.7512±0.01*
	20min	7.1275±0.01*	7.1275±0.01*	7.1275±0.01*	7.1275±0.01*

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