

THE INFLUENCE OF THE CO₂-EXTRACTION PROCESS ON THE MICROBIAL CONTAMINATION OF VEGETABLE RAW MATERIAL

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Abstract: The supercritical CO₂ extraction method allows both to obtain a product without solvent residues as well as one microbiologically safe. It was analyzed various vegetable raw materials: walnut kernel meal, tomato wastes, grape seeds, pumpkin seeds and wheat germ. It was found that the CO₂-extraction process has a positive influence on the degree of microbial contamination of raw materials. Due to the high pressure (up to 40MPa), the number of aerobic and facultative anaerobic microorganisms as well as yeast and mold units decreases about ten times in the meal comparing to the raw material. Also, it was found that the CO₂- extraction process destroys the coliform bacteria.

Keywords: supercritical CO₂ extraction, raw material, contamination, microorganisms

Introduction

Numerous investigators have studied the effect of pressurized CO₂ on cell viability for the sterilization and inactivation of micro-organisms. Mechanisms that have been proposed for the antimicrobial activity of pressurized CO₂ take advantage of its increased solubility relative to atmospheric conditions and include the following: cell rupture by the rapid depressurization of high pressure CO₂, the extraction of cell wall lipids, the penetration of pressurized CO₂ into the cellular membrane disrupting membrane properties, and the lowering of the intracellular pH by the dissolution of CO₂ within the cell [1].

However, lowering of the pH of the media alone cannot describe the inhibition by pressurized CO₂. Acids that do not penetrate the microbial cells as readily as CO₂ (i.e., hydrochloric acid and phosphoric acid) do not inhibit the cells as greatly [2, 3].

The extent and mechanism(s) of microbial inactivation by pressurized CO₂ are dependent on the method of contacting between CO₂ and the cell mass, the depressurization scheme, and the operating temperature, pressure, and phase. The nature of the cell (bacterial, yeast, or fungal, and gram positive or gram negative) and the system water activity also impact the extent of sterilization of microbes [1, 4].

It was studied the influence of CO₂-extraction parameters on the microbial contamination of different raw materials: walnut grist, tomato wastes, pumpkin seeds, wheat germs and grape seeds. The determination of microbial contamination was carried in accordance with GOST 10444.15-94, GOST 30518-97, GOST 10444.12-88 and GOST 10444.12-88.

The obtained results are presented in tables 1-5.

Table 1. Microbiological indices of walnut grist

Name of index	Walnut grist after cold pressing	CO ₂ -extract from walnut grist	Walnut grist after CO ₂ -extraction
The number of mesophilic aerobic and facultative anaerobic microorganisms CFU/1 g	2*10 ⁴	2,0 *10 ²	7.5*10 ³
Coliform bacteria in 1 g and 0.1 g product	Was found	Not found	Not found
Yeast, UFC/1g product	8.0*10 ²	2,0*10 ¹	<1*10 ¹
Mold, UFC/1g product	<1*10 ¹	<1*10 ¹	<1*10 ¹

It was established that the number of mesophilic aerobic and facultative anaerobic microorganisms decreased hundred times in CO₂-extract and ten times in walnut grist after CO₂-extraction process. This process has a positive influence on the destruction of coliform bacteria, which were not detected in the extraction products.

Table 2. Microbiological indices of wheat germs, CO₂-extract from wheat germs and grits obtained from these

Name of index	Wheat germs	CO ₂ -extract from wheat germs	Wheat germs grist after CO ₂ -extraction
The number of mesophilic aerobic and facultative anaerobic microorganisms CFU/1 g	1,2*10 ³	5,0 *10 ¹	1,1*10 ²
Coliform bacteria in 1 g and 0.1 g product	Not found	Not found	Not found
Yeast, UFC/1g product	<1*10 ¹	9,0*10 ¹	<1*10 ¹
Mold, UFC/1g product	6,0*10 ²	1,0*10 ²	3,1*10 ²

According to table 2, the number of mesophilic aerobic and facultative anaerobic microorganisms decreased hundred times in the CO₂-extract from wheat germs and ten times in the grist after CO₂-extraction process.

Table 3. Microbiological indices of dried tomato wastes and grits obtained from these

Name of index	Dried tomato wastes	Grist from dried tomato wastes obtained with CO ₂	Grist from dried tomato wastes obtained with CO ₂ and ethanol
The number of mesophilic aerobic and facultative anaerobic microorganisms CFU/1 g	1.9*10 ⁵	1.2*10 ⁴	7.0*10 ³
Coliform bacteria in 1 g and 0.1 g product	Not found	Not found	Not found
Yeast, UFC/1g product	4.0*10 ⁵	2.2*10 ⁴	2.2*10 ³
Mold, UFC/1g product	<1.0*10 ¹	<1.0*10 ¹	<1.0*10 ¹

According to table 3, in the analysed samples it wasn't found the coliform bacteria, but the number of mesophilic aerobic and facultative anaerobic microorganisms decreased about 3 times in grist from dried tomato wastes obtained with CO₂ and ethanol and 1.5 times in grist from dried tomato wastes obtained with CO₂ toward dried tomato wastes. The number of yeast decreased 18 times in grist from dried tomato wastes obtained with CO₂ and 182 times in grist from dried tomato wastes obtained with CO₂ and ethanol.

Table 4. Microbiological indices of pumpkin seeds and grits obtained from these

Name of index	Pumpkin seeds	Grist of pumpkin seeds
The number of mesophilic aerobic and facultative anaerobic microorganisms CFU/1 g	2.1*10 ⁵	1.1*10 ⁴
Coliform bacteria in 1 g and 0.1 g product	Not found	Not found
Yeast, UFC/1g product	2.2*10 ¹	2.0*10 ¹
Mold, UFC/1g product	<5.0*10 ¹	<1.0*10 ¹

It was established that in 1.0 g of pumpkin seeds and grist of pumpkin seeds coliform bacteria was not detected. It was determined that the CO₂ extraction process does not have any influence on the number of yeast – 2.2·10¹ for pumpkin seeds and 2.0·10¹ grist of pumpkin seeds. Regarding the degree of contamination with mold, it seems that CO₂-extraction acts on them, reducing their number. Thus, if 1.0 g of pumpkin seed meeting <5.0·10¹ of the mold, then 1.0 g of pumpkin seed grist extracted with CO₂, their number decreased substantially, about 5 times, reaching a value of <1.0·10¹.

Table 5. Microbiological indices of grape seeds and grits obtained from these

Name of index	Grape seeds	Grist of grape seeds obtained with CO ₂	Grist of grape seeds obtained with CO ₂ and ethanol
The number of mesophilic aerobic and facultative anaerobic microorganisms CFU/1 g	3.6*10 ⁵	1.9*10 ⁴	4.2*10 ³
Coliform bacteria in 1 g and 0.1 g product	Not found	Not found	Not found
Yeast, UFC/1g product	2.4*10 ⁵	1.6*10 ⁴	8.0*10 ²
Mold, UFC/1g product	2.0*10 ²	1.0*10 ²	1.4*10 ²

According to table 5, in the analysed samples it wasn't found the coliform bacteria, but the number of mesophilic aerobic and facultative anaerobic microorganisms decreased about 19 times in grist of grape seeds obtained with CO₂ and 86 times in grist of grape seeds obtained with CO₂ and ethanol. The number of yeast decreased 15 times in grist from grist of grape seeds obtained with CO₂ and 300 times in grist from grape seeds obtained with CO₂ and ethanol.

Conclusions

1. The destruction of microorganisms by the CO₂-extraction process is due to several factors such as: nature of the microorganism, dissolution of CO₂ within the cell, the parameters that influences the method of contacting between CO₂ and the cell mass, the depressurization scheme, and the operating temperature, pressure, and phase.
2. It was established that the CO₂ extraction process diminishes the number of microorganism of vegetable raw material tens or hundreds of times.
3. It was demonstrated that the use of ethanol in the extraction process significantly reduces the degree of contamination with microorganisms of vegetable raw material.

References

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