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*Corresponding author: Fayzullayev Asqar, Bukhara Engineering, Technology Institute, Uzbekistan, E-mail: fayzullaev_asqar_2020@mail.ru

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Research Article

Supercritical fluids state of CO₂ and its the technological performance

NR Barakaev, MT Kurbonov, BT Mukhamadiev and Fayzullayev Asqar*

Bukhara Engineering, Technology Institute, Uzbekistan

Abstract

The prospect considered of the using Super Critical Fluids (SCF) for extraction fat, ethereal oil from seed grape. Possibility of the use is shown for this and its problems bound by accessibility of the high-priced equipment.

In the last decennial event in developed country of the world is actively developed problem of the rational use material in supercritical condition in closing technological cycles and the other high technology.

One of the decisions given problems is a using as extract liquefied carbon dioxide. In the world spreads exactly CO₂ extraction. This is bound in the first place with that that this process highly profitable, more technological, allows to produce the conversion not only high-quality cheese, but also departure production for the reason extraction of them main component for giving more high quality low sort of the product. The Extraction by carbon dioxides in liquefied condition greatly increases the spectrum selected biologically active join, as well as allows to get such concentrations biologically active material in final product, which impossible get nor one of other known methods of extractions.

Introduction

The Extraction by CO₂ known in near and distant foreign country it is enough long ago, already in 60-s years past age effort Krasnodar and Moscow scientist were an uncared-for production shop on production CO₂-extract [1].

But science and technology moves toward, and that earlier was inaccessible, at present available, as well as in the course of time appears need on more high effectively ways and methods. The scientists have realistically shown the unique characteristic different material in supercritical condition, including carbon dioxide. Strictly, from this time of the notion "CO₂-extractions" and "CO₂-extract" changed [2].

The Development to technologies of the using CO₂ in different branch of the economy, so named CO₂-chemistry, CO₂-metallurgy, CO₂-clear, other nanotechnology on west country well-earned has got the name true "technologies 21 ages".

Theoretical part

At present technologies production extract is designed from the following medicinal and aromatic plants: anise, root, basilica, carnations, highlander pepper, angelica, coriander, laurel cinnamon, turmeric, sheet nut nutmeg, seed carrot, parsleys, wormwood, pepper leguminous red, pepper fragrant, pepper black bitter, caraway, sage medicinal, mulberries, sage nutmeg, dill smelling, fennel, pine-needles of the fir, hop, tarragon, as well as from dry cheese.

Use to technologies extraction ethereal oil from plants by carbon dioxide allows to extract from vegetable cheese practically full complex material in their natural state and high concentration (98-99 % at purity of the product 99,9%). CO₂-extracts are intended for use in perfume-make-up, medical, food, in particular, in beer, wine, confectionery, meat industry, as well as in home chemistry.

CO₂-extracts present itself fluid or products, with strong, typical of source cheese by scent; the mass share humidity not

more than 5%; completely open in butter, alcohol, acetic acid, not soluble in water, but form strong emulsion with her.

SC- CO₂ extracts present itself:

- a complex biologically active material (essential oils, terpens, fat acids, fenol containing join, vitamins, pigments, alkaloids and others) in its natural form, practically extract copies the source vegetable raw material moreover material are found in proportion characteristic source of raw materials;
- have brightly expressed aromas and gustatory quality medicinal rubbed and dry of the same name spices;
- present ecological pure products;
- are not damaged vermin;
- unlike dry cheese microbiological not sterile and possess the bactericide and bacteriostatic characteristic that prolongs keeping the product;
- is not littered product to vital activity micro flora, does not contain the pesticides and herbicide;
- do not lose their own characteristic, aroma and taste in process of keeping;- are easy formed in compositions.

Use CO₂-extract allows to exclude using dry spicy-aromatic material and enables to get the produced product to uniform consistency without mixing dry spices.

Effect from use CO₂-extract in lieu thereof dry material increases in several times, decrease the expenses on transportation and keeping, appears the possibility to mechanize (automate) process addition extract to products.

Use CO₂-extraction ethereal oil as softly timing, more labor-consuming and technologically quick way of the processing medicinal and spicy-aromatic vegetable cheese is a necessary condition of the reception natural ecological pure ethereal oil high quality. In they are saved natural correlation all component and, consequently, biochemical composition and physiological activity.

The raw material for reception CO₂-extract is a different plants, spicy-aromatic products, secondary raw materials facility processing branches (the seed of grape, pits fruit, fruit and beverage), products animal origins.

The particularities of the structure vegetable cheese our region, fruit pit and other care departure, expect the development technological mode to extractions with using the fluid carbon dioxide, kinetics and speakers of the process to extractions, as well as effect factor such as differences pit and grain, their amounts, the temperature of the processing, mixture of the organic solvents with liquefied gas on output and quality of the got product.

The modern requirements of food industry - a reinforcement of the checking for undesirable remainder in food-stuffs (the pesticides, heavy metals and others.).These

afford will hereinafter extend to many technological processes in food technology, including extraction gustatory (aromatic and biologically active material). In this connection of no small importance importance has an assesment to extractions of the natural products.

Last production of the different spices is introduced in our country as local, so and tropical origin. However existing way to use the spices in natural type are not deprived such defect, as low utilization ratio aromatic and gustatory material and high bacterial content spices, causing premature product damage, particularly not subjected to sterilizations. Consequently, scientific development to new technology and using natural aromatics in the form of extract has a prospect. For minimization of the competitions synthetic material alternative technology to extractions must be designed as more efficient. Such technology is an extraction liquefied gas in different their condition - fluid and compressed [1-5].

Results and discusion

Such gases attract attention as perspective extraction, which efficient using is connected with their characteristic:

1. The varied type liquefied gas and their mixtures between itself and with other organic solvent, as well as possibility of conduct to extractions under thermodynamic condition before - and supercritical allows to change selectivity of the process, obtaining receptions extract with necessary characteristic and composition.
2. The low temperature of the boiling, high volatility liquefied gas allows to realize the distillation micelles in soft warm-up condition that provides the reception high-quality extract (flying material are saved) from other oil aromatics and medicinal products.
3. Many liquefied gases possess the characteristic in inhibitor flame and possible on base of their additives in the main hydrocarbon solvents, applicable in other oil aromatics and fats to technologies, provide save extraction.
4. Indeed all liquefied gases possess the characteristic to form with water crystal hydrates and this can be used for concentration and peelings water solution in system of the extractions.
5. High inside energy, small viscosity and hiding heat of the evaporation allow to build efficient in energy attitude of the scheme to extractions.
6. The high partial pressure liquefied gas can be used for change structured characteristic capillary-cell vegetable material up to their pulverizing that it is important in connection with improvement of the processes of preparation material to extractions.

The CO₂ - net, non-explosive, not flaring up, nontoxic solvent. Besides, energy expenses, connected with new process of the extractions lower, on traditional method.

The Extraction liquefied gas in before up critical and supercritical area will always be more economical, than extraction by traditional methods if target components have high value (for instance, for local cheese extraction lipids from grape pit, extraction aromatic and gustatory material of the spices etc.), as well as at association many steps process in one.

From large number of the possible using CO₂ - an extraction in food industry after studies and check shall note following mastered and perspective directions.

1. The aromas and extracts (the fruit aromas, α - an acids from grape pit).
2. The extracts of the spices.
3. Lecitine.
4. Refinement fat.
5. Vegetable butters and fat.
6. Non oil proteins and potato chips.
7. Natural dying material (the red pepper).
8. Antioxidants.
9. The lover of the alcohol in drink (or extraction of the alcohol from water solution).

Exists the raw an obstacle to spreading of this technologies in industry;

1. The Expenses given technologies all else high and problems of the increase the scale in carrying from separate significant using to full scale significant.
2. At present process marketed as periodic and thereby does not approach to many modern continuously acting production. In this connection understandable longing to create continuously - acting technology. This is perfect potential spreading new extraction of technologies.

The Extraction gas before - and over critical condition gives industry new technology and possibility to get the new valuable products. Certainly that continuing development will enlarge capacity now existing equipment, but creation continuously acting equipment will allow to increase their industrial using. The Best understanding the process necessary both on theoretical, and on practical level that this technology could benefit for development of food industry.

The bases choice to new technology to extractions gas are:

1. Division by traditional methods impossible or expensive or unsatisfactory.
2. At least once one of the characteristic (better if more) liquefied and compressed gas solves a problem.
3. Value got target product justifies the economic expenses.

The most important is a last criterion. No estimations of the standard expenses on extraction gas in liquefied and compressed condition and each using must be evaluated individually. Under greater economic expenses choice application to extractions under pressure is limited by special events, in which one or more characteristic given process solves a problem.

At choice extract ants for spicy-aromatic, the ether oil and medicinal vegetable cheese follow the requirements, presented to industrial solvent and reducing to the following basically:

1. High selectivity and sufficient dissolving ability.
2. Chemical no differentiability to extracted material and technological equipment.
3. The Absence after evaporation stranger spare and bad for person material in aim product.
4. The Uniform stable composition, constant and besides low temperature of the boiling, the least heat capacity, heat of the evaporation and viscosity.
5. No fire and absence explosive mixture with air.
6. The Absence of the colloidal systems and hydrofobility.
7. Colorlessness.
8. Safety for servicing personnel.
9. The cheap and accessibility the most efficient way receptions vegetable extract with using as extract ants of the flying solvents, in the first place, food fluid CO₂ [1-6], representing itself colorless liquid without scent, warm-up range of the using fluid CO₂ much expansive and allows to extract both in plus, and in minus to temperature. The low critical temperature and small importance of the hidden heat of the evaporation allow to lead the extraction with fluid CO₂ with small specific expenses of the heat.

The extraction and evaporation of the solvent under low temperature (before 50°C) can not only to extract the essential oils, saving aroma source cheese, but also biologically active components in active condition [2]. Fluid CO₂ does not support vital activity a microorganism and mildews that allows to get the sterile products when use cheese even, milling microorganism fluid CO₂ thermal firm under usual temperature, chemical inert. The extraction in ambience fluid CO₂ excludes completely oxidation to account of the absence to aerations. The branch of the solvent from extract possible or reduction of the pressure or heating, translating fluid CO₂ in gaseous condition, herewith stands out CO₂ - an extracts.

Variation main parameter to extractions - a temperature, pressures, length, nature and degree dispersion extracted material - allows to get the product of the necessary composition [6].

Using fluid CO₂, aside from technological advantage, as solvent economic reasonable since she is cheap and available flying solvent [7-13].

For extraction vegetable cheese CO₂ is used in the following conditions [13].

1. Fluid, before critical,
2. Critical,
3. Fluid supercritical,
4. Gaseous supercritical (before critical),

On the grounds of considered material on CO₂ - an extractions possible to do the following findings.

1. "Scientific direction" CO₂ - an extraction" is perspective and intensive developing. Particularly perspective and intensive develops over critical extraction by carbon dioxide.
2. Technology of the reception CO₂ - an extract is designed for broad circle vegetable material, however, technology is not it is enough made, the main difficulty for spreading of technologies over critical extraction by carbon dioxide is need of the making the equipment on high pressure, which must be safely used, with required by capacity and acceptable energy requires. At development extraction installation is not spared attention to accessory and is not considered functioning the installation as systems.
3. The most wide-spread is a problem to extractions varied oil containing material, which under usual mode over critical extraction by carbon dioxide require using the pressures at a rate of 40-50 MPA and more.
4. The study of the kinetics of extractions before and supercritical CO₂ were executed in laboratory condition herewith it is not enough are taken into account particularities of the large installation, connected with longitudes mixing phases of the solvent in layer extracted material.
5. The known different offers on determination diffusion and equilibrium characteristic for supercritical systems, however accuracy their low for fatty mixtures. The studies on mass exchange in supercritical condition it is not enough and they are absent for membrane to extractions. This study used a supercritical (SK) of CO₂-extraction to extract glycyrrhizic acid (GA) from the licorice root. To do this, define the conditions (preliminary experiments) of the extraction process, namely, the temperature, pressure and fluid flow SK (CO₂). Given that this process is multifactorial, the method RSM-response surface methodology and CCRD-central composite rotatable design used to determine the optimum operating conditions of the process. The effectiveness of the established SC-CO₂ extraction conditions, expressed GA content in the extracts as compared with a yield of GA produced by the conventional extraction method, when applied SC-CO₂ modified polar co-solvent (ethanol).

In describing the GA yield predictions using appropriately combined with RSM CCRD(response surface methodology), we found that the yield of GA mainly depends on the pressure and quantity of SC-CO₂ used for extraction. It turned out that there is a significant relationship for the linear and quadratic terms of the relationship between the output of the GA and these parameters. Noticeable interaction between the three process parameters (pressure, SC-CO₂ temperature and flow rate) was observed.

Licorice root is subjected to moisture-heat pre-treatment. Cooked thereafter pitch used as a raw material for the extraction of GA by SC-CO₂ extraction. Initial studies for a wide spectrum of SC-CO₂ density value (780-890 kg/m³) indicates that it is possible to set optimum operating conditions for the GA separation.

According to RSM-analysis of the optimal process conditions: 14.6 KPa, 33.5 ° and 21.88 g CO₂/g.d.m. CO₂ consumption for the extraction of GA from licorice using SC-CO₂. SC-CO₂ density calculated for the optimum pressure and temperature equal to 885 kg/m³, which was found as a result of a preliminary analysis of the correlation between the output of the GA and CO₂ density. The maximum yield of GA is equal to 0.158 g of 1 g of dried material (about 15% of extract) with SC-CO₂ density equal 863 kg/m³.

Preliminary tests performed at condition resulting in SC-CO₂ density ranging from 780 to 890 kg/m³ indicated that at some pressure, temperature as well as consumption of supercritical fluids the optimal working conditions for glycyrrhizic acid isolation could be determined. For thus purpose the following range of working conditions of SK-CO₂ were tested by using Central Composite Rotatable Design (CCRD) and Response Surface Methodology (RSM): pressure from 16 to 34 KPa, temperature from 20° to 40° and consumption of SC-CO₂ from 10 to 26 gCO₂/gd.m. The results of this investigation indicated that maximum yield G.A. 158 mg from 1 g materials on dry basis (about 15% of total extract) at 14.6 KPa, 33.5 ° and 21.88 gCO₂/gd.m. could be obtained [14-16].

Conclusion

In accordance with considered and made conclusion possible to mark the main trends of the improvement of the process of extractions by carbon dioxide in food industry:

1. Develop the theoretical bases processes to extractions by carbon dioxide lay extracted material and develop the mathematical model, conduct modeling of the process of extractions.
2. Conduct the theoretical analysis and develop the mathematical model of the process of liquid extraction in new designed device.
3. Conduct the basic researches and value the parameters of the processes to extractions oil containing material on solubility and diffusions component, deleted under extraction clear vegetable oil and create the mathematical model of the process of division mixture threeglycerates and fat acids.



4. Conduct the thermodynamic motivation to efficiency to extractions by carbon dioxide with co-solvent, research the phase conditions “CO₂ – an ethanol “ and “CO₂ – an ethanol – fat” in connection with development of the supercritical extraction oil-containing material under lowered pressure.

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