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APPLICATION REPORT

EX06 - GINGER FLAVORS

Ginger Microwave Hydrodiffusion and Gravity (MHG)

Introduction

Due to its composition in valuable natural compounds, ginger represents a suitable matrix for extraction of essential oil as well as many other bioactive compounds. It contains indeed products of interest such as essential oils (1–4%), phenolics (gingerols and 6-shogaol, 1–2%), and total carbohydrates (60–75%). Ginger, and more specifically rhizomes are variously used as food product or in traditional medicine. In the food industry, rhizomes are mainly used for spices or condiments (fresh or dried), candy or as juice after cold mechanical pressing. Due to the fact that mechanical pressing does not alter the chemical composition of the pressed product, this process provides huge amounts of press cake still containing high amounts of bioactive compounds, which is currently considered as waste. The novelty of the extraction of these products through MHG and SFME relies on the extraction of compounds achieved without addition of solvent or water. The only water used in the process is the matrix water naturally present in the plant cells [1].

[1] M. Navarro-Jacotet, N. Rombaut, S. Deslis, A. Fabiano-Tixter, F. Pierre, A. Bily, F. Chemat, Green Chemistry 2016, 18, 3016.

Why to choose Microwave Flavor set-up?

The patented and revolutionary Microwave Hydrodiffusion and Gravity (MHG) system pays the way to new flavoring products which were impossible to be obtained with the ancient extraction concepts. Percolation, solvent extraction ecc… were inefficient and environmental-unfriendly methods of flavor extraction. MHG is going to improve the efficiency and the quality of flavoring products.

- New natural flavors
- Fast extraction
- No thermal degradation
- No solvent

Instrumentation and Principles of Operation

A very efficient extraction process can be achieved thanks to the selective heating of microwaves to materials through molecular interactions with the electromagnetic field via conversions of electromagnetic energy into thermal energy. The high quality fragrance were obtained through the MHG techniques (see the “Microwave Extraction Techniques” section for theory and principle).

Results and experimental procedure

The MHG technique is suitable for both dry and fresh raw material, see the “Quick start guide” for a list of easy and sequential setting-up operations (*Table 1*).

Fresh Ginger (MHG)						
Reactor	Weighted fresh raw material [g]*	Power [W]	Chiller		Total flavour extract [mL]	Total flavor extract yield [%]
			1kW	2.1kW		
Small	1000	1000	•		388	38.8
Medium	3160	1800		•	1230	39
Large	7445	1800		•	2910	39.1

*Time, Power
≤ 1800 g: Power(W) = Weight(g) for 20 min.
> 1800g: Power = 1800W for 40min
Chiller settings:
≤ 900g, 1 kW Chiller
> 900g, 2.1 kW Chiller

Table 1

Important remarks

Please take into account that the interaction between microwaves and raw material is based on the water content. The optimized method (power and time) depends on the type of Ginger, mainly to the water content of Ginger itself. Please use the reported parameter as general application note to start to optimize your own method. Be careful, that using an excess power might cause burning of your sample.
Please take care to seal properly the glass reactor during the installation of the flavors set-up according to the manual, to avoid loss of vapor during extraction.

Conclusion

A newly and cleaner design process for extraction of flavors was developed in this study: MHG. This green process has been studied and tested using ginger. This new system was developed to date indicate that microwave extraction process of flavors offers important advantages over antiquated extraction techniques, namely, shorter extraction times, less energy consuming, lower costs as well as new flavoring products. The MHG system offers furthermore the possibility to work with scalar amounts of sample due to three different reactor vessels (small, medium, large), complying with a high range of extraction-scale needs.

APPLICATION REPORT

EX07 - GINGER FRAGRANCES

Ginger Solvent-Free Microwave Extraction (SFME) and Microwave Hydrodistillation (MWHD)

Introduction

Due to its composition in valuable natural compounds, ginger represents a suitable matrix for extraction of essential oil as well as many other bioactive compounds. It contains indeed products of interest such as essential oils (1–4%), phenolics (gingerols and 6-shogaol, 1–2%), and total carbohydrates (60–75%). Ginger, and more specifically rhizomes are variously used as food product or in traditional medicine. In the food industry, rhizomes are mainly used for spices or condiments (fresh or dried), candy or as juice after cold mechanical pressing. Due to the fact that mechanical pressing does not alter the chemical composition of the pressed product, this process provides huge amounts of press cake still containing high amounts of bioactive compounds, which is currently considered as waste. The novelty of the extraction of these products through MHG and SFME relies on the extraction of compounds achieved without addition of solvent or water. The only water used in the process is the matrix water naturally present in the plant cells [1].

[1] M. Navarro-Jacotet, N. Rombaut, S. Deslis, A. Fabiano-Tixter, F. Pierre, A. Bily, F. Chemat, Green Chemistry 2016, 18, 3016.

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Why to choose Microwave Fragrances set-up?

The standard method is the Clavenger method, which was published for the first time in 1928. According to that method, the essential oil from Ginger can be extracted by hydrodistillation or steam distillation. These techniques take several hours of heating which may cause degradation of thermolabile compounds present in the starting plant material and therefore odor deterioration. The patented and innovative Microwave Hydrodistillation (MWHD) and Solvent-free Microwave Extraction (SFME) techniques allow the production of essential oils with higher quality.

- High quality frangrances
- No thermal degradation
- Fast extraction
- High purity, no artifacts

Instrumentation and Principles of Operation

A very efficient extraction process can be achieved thanks to the selective heating of microwaves to materials through molecular interactions with the electromagnetic field via conversions of electromagnetic energy into thermal energy. The high quality fragrance were obtained through the SFME or MWHD techniques (see the "Microwave Extraction Techniques" section for theory and principle).

Results and experimental procedure

The SFME and the MWHD techniques are respectively suitable for fresh and dry raw materials. See the "Quick start guide" for a list of easy and sequential setting-up operations (*Table 2*).

Fresh Ginger, SFME						
Reactor	Weighted fresh raw material [g]*	Power [W]	Chiller		Volatile fraction [mL]	Yield [%]
			1kW	2.1kW		
Small	1000	1000	•		0.7	0.08
Medium	3160	1800		•	2.2	0.07
Large	7445	1800		•	5.2	0.07

*Time, Power
The extractions were carried out till complete recovery of the fragrance
≤ 1800 g: Power(W) = Weight(g).
> 1800g: Power = 1800W
Chiller settings:
≤ 900g, 1 kW Chiller
> 900g, 2.1 kW Chiller

Table 2

Important remarks

The system is developed with an automatic recirculation of the distilled water. This allows to manage extraction power and time to match your own specific requirements. Please take care to seal properly the glass reactor during the installation of the fragrances set-up according to the manual, to avoid loss of vapor during extraction.

Conclusion

In this study, we propose state-of-the-art processes for extraction of essential oils from Ginger through SFME and MWHD. It is the unique modern concept of the antiquated Clavenger method, highly accelerating the isolation process, without causing changes in the volatile oil composition. The efficiency of the new techniques SFME and MWHD are considerably higher than the conventional procedure, if we take into account short distillation times required, cost and energy used and cleanliness of the process. An added-value feature is the possibility to work with scalar amounts of sample due to three different reactor vessels (small, medium, large), complying with a high range of extraction-scale needs.

		GR	GP	0.6 W g^{-1}	0.8 W g^{-1}	1.0 W g^{-1}	1.2 W g^{-1}	1.4 W g^{-1}	1.6 W g^{-1}	1.8 W g^{-1}
Essential oil *Yield (g per 100 g fresh plant material). Major compounds (%)*		0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	β-Pinene	1.2	1.0	2.3	2.6	2.4	2.6	2.3	2.4	2.2
	Camphene	4.3	3.8	9.1	10.3	9.2	10.0	9.1	9.4	9.1
	Sabinene	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Sulcatone	0.0	0.8	1.2	2.8	3.3	3.2	3.0	3.2	2.9
	Myrcene	0.6	0.6	0.0	1.4	1.4	1.4	1.3	1.3	1.1
	α-Phellandrene	0.2	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.1
	Limonene	0.9	0.9	1.7	1.9	1.9	1.9	1.7	1.8	1.7
	β-Phellandrene	4.6	4.2	8.7	10.4	10.3	10.2	9.7	10.0	8.6
	Terpinolene	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.3	0.2
	Linalol	0.2	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.4
	Borneol	0.5	0.6	0.8	0.9	1.0	0.9	1.0	1.0	1.1
	α-Terpineol	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.6
	Citronellol	0.1	0.3	0.2	0.5	0.4	0.3	0.4	0.4	0.8
	Neral	1.7	0.5	0.4	1.3	1.5	1.7	1.5	1.5	1.3
	Geraniol	0.1	0.2	0.1	0.3	0.3	0.2	0.2	0.2	0.6
	Geranial	3.3	1.0	0.6	1.9	2.2	2.6	2.3	2.5	2.3
	Geranyl acetate	0.3	0.1	0.4	0.2	0.2	0.2	0.2	0.2	0.2
	α-Curcumene	3.5	13.9	17.0	7.6	7.2	6.6	7.0	6.8	9.9
	Germacrene D	1.6	1.3	0.1	1.3	1.4	1.4	1.4	1.4	0.7
	Zingiberene	35.7	25.2	18.4	23.2	24.0	24.0	25.1	24.3	18.4
	α-Farnesene	6.5	6.5	6.3	5.4	5.5	5.5	5.7	5.5	5.7
	β-Bisabolene	5.7	6.8	0.0	4.8	4.7	4.6	4.8	4.7	5.4
	β-Sesquiphellandrene	12.1	13.9	12.3	9.9	9.9	9.7	10.2	9.8	10.4
Antioxidants *Total content (g per 100 g plant material DW). Major compounds (g per 100 g plant material DW)*		1.17	0.90	0.57	1.24	1.06	1.18	1.22	1.37	1.18
	6-Gingerol	0.77	0.58	0.31	0.81	0.65	0.79	0.81	0.92	0.79
	8-Gingerol	0.15	0.11	0.07	0.14	0.11	0.14	0.14	0.17	0.14
	10-Gingerol	0.23	0.19	0.11	0.18	0.19	0.19	0.19	0.21	0.19
	6-Shogaol	0.02	0.02	0.08	0.11	0.10	0.08	0.09	0.08	0.08

Table 3. Volatile compounds and antioxidants extracted from ginger plant material by SFME