Extraction and Analysis of Fresh Ginger Root and Ginger Dietary Supplement

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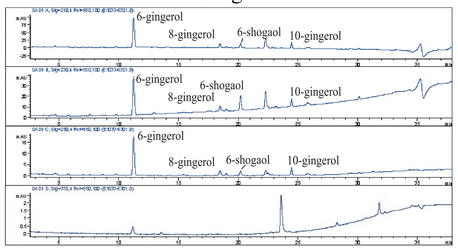
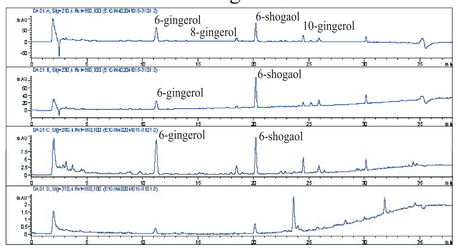
Abstract:

Traditional Hawaiian and ayurvedic medicine uses ginger root to relieve inflammation. The active ingredient(s) in ginger that decrease inflammation are not known and thus any processing of the fresh product into a dietary supplement risks losing the crucial compound(s). This project compared the chemical composition of raw ginger to processed root in the form of a selected commercially available dietary supplement capsule. A reverse-phased high-pressure liquid chromatography method was developed to separate three gingerols (6, 8 and 10) and 6-shogaol, four of the active compounds in ginger. Standards of these components were used to identify and quantify the compounds in the various ginger extracts. To obtain the extracts, five different solvents (water, methanol, dichloromethane, hexane, and a 80:20 methanol-water mixture) were used. Repetitive dilutions were used to determine the extraction efficiency and ensure complete extraction using the different solvents. The amount of the four analyzed compounds in each extract varied depending on the solvent used, but in each case they represented only a small percentage of the extract, and an even smaller percentage of the entire sample. Amongst the analyzed components 6-shogaol was found almost exclusively in the extracts of the dietary supplement ginger sample. This fact is most likely due to the oxidation of 6-gingerol into 6-shogaol during manufacturing and storage. The extracts were also analyzed by liquid chromatography/mass spectrometry (LC/MS) to identify other components present in the extracts.

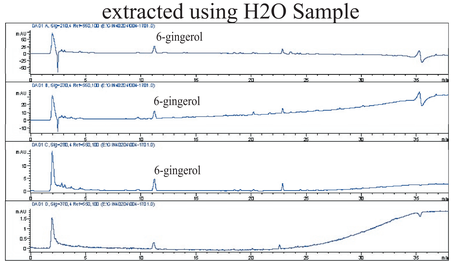
HPLC Chromatogram of Fresh Ginger Sample Extracted using MeOH:H20



HPLC Chromatogram of Retail Ginger Sample Extracted using MeOH:H2O



HPLC Chromatogram of Retail Ginger Sample extracted using H2O Sample

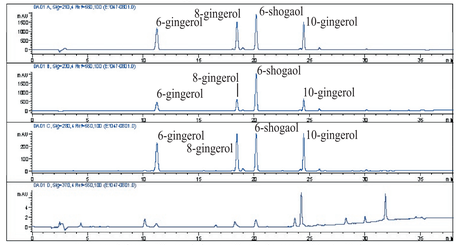


Introduction

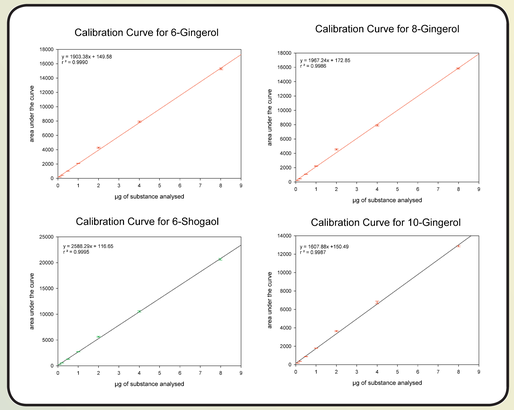
Ginger is renowned for its multiple medicinal uses. Ancient Hawaiian medicine recommends ginger to relieve headache, toothache, achy joints, and stomachache as well as various other maladies[1]. Modern herbal medicine uses ginger primarily to treat motion sickness, however its anti-inflammatory properties can also help to treat migraine headaches, rheumatic and muscular disorders, arthritis, and other inflammation related ailments[2]. The analyzed active compounds in ginger for this study are 6-, 8- and 10-gingerols, as well as 6-shogaol. The purpose of this investigation is twofold:

1. To determine the most effective solvent for gingerol/shogaol extraction
2. To analyze differences between the gingerol/shogaol content of fresh ginger and ginger dietary supplement capsules.

HPLC Chromatogram of a Standard Mixture



400.9 ug/ml 6-gingerol; 399 ug/ml 8-gingerol; 399 ug/ml 6-shogaol; 399.9 ug/ml 10-gingerol



Conclusion

Ginger is a potentially very effective phytomedicine in treating a wide variety of illnesses. Efficient extraction of potentially and practically beneficial compounds from ginger is an important step in our understanding and efficient use of its medicinal properties. This project found that an 80% methanol:20% water mixture was the most effective solvent in the extraction of the four investigated compounds. Methanol proved effective in the extraction of ginger capsules and DCM was effective in extracting fresh ginger.

Procedure

1. Both kinds of ginger samples were ground/removed from the capsules, weighed, and mixed with solvent
2. Suspension was sonicated for one hour at room temperature
3. Repetitive dilutions were performed to ensure complete extraction
4. The solution was filtered to remove insoluble particles, and the solvent was evaporated
5. Extracts were analyzed using Agilent 1100 HPLC system (20 µl sample in Synergy 4µ Hydro column (250 x 4.6 mm). Eluent monitored using diode array detection at 210, 230, 280, and 370 nm
6. Calibration curves were created using authentic standards of 6-, 8-, 10-gingerol and 6-shogaol obtained from Dalton Chemical Laboratories
7. Extraction efficiency and the composition of the extracts were calculated

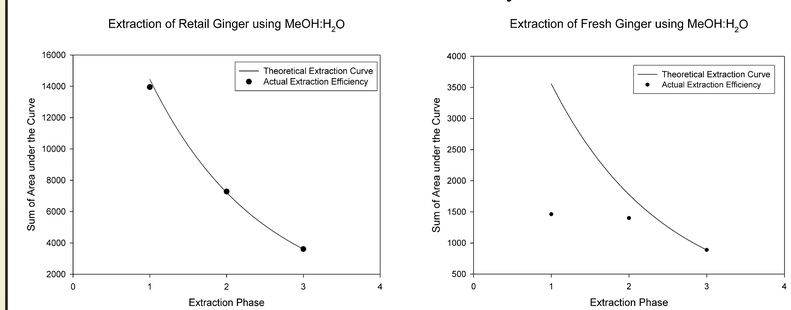
Chemical Composition of Samples

	6-gingerol (%)	8-gingerol (%)	6-shogaol (%)	10-gingerol (%)
Retail Ginger				
Extraction Solvent				
H2O	0.19 ± .03	0.01 ± .01	<0.01 ± <.01	0.01 ± <.01
MeOH	0.32 ± .05	0.05 ± .01	0.27 ± .05	0.16 ± .02
DCM	0.12 ± .05	0.02 ± .01	0.12 ± .05	0.06 ± .04
Hexane	0.05 ± .04	0.03 ± .01	0.11 ± <.01	0.08 ± <.01
MeOH:H2O	0.29 ± .12	0.05 ± .02	0.24 ± .09	0.11 ± .04
Fresh Ginger				
Extraction Solvent				
H2O	<0.01 ± <.01	<0.01 ± <.01	<0.01 ± <.01	<0.01 ± <.01
MeOH	0.11 ± .02	0.01 ± <.01	0.01 ± <.01	0.03 ± <.01
DCM	0.15 ± .01	0.03 ± .01	0.01 ± <.01	0.03 ± <.01
Hexane	0.01 ± <.01	<0.01 ± <.01	<0.01 ± <.01	<.01 ± <.01
MeOH:H2O	0.16 ± .03	0.02 ± <.01	0.02 ± <.01	0.04 ± .01

MeOH:H_2O proved an effective solvent for both fresh and retail ginger, however methanol was also an effective solvent for retail ginger, as was DCM likewise for fresh ginger.

It is interesting to note that the compounds investigated in this experiment compose a very small percentage of the extract, and an even smaller percentage of the entire sample. In fresh ginger, this is understandable, as the root contains a large amount of moisture that was lost during the extraction. The retail capsule, however, is an extract in itself and claims to have a far higher percentage of gingerols than is actually present.

Extraction Efficiency



The collected extraction data is fitted to a theoretical extraction curve (assuming immediate complete extraction), and the point at which the data points fit onto the theoretical axis is the point of known complete extraction. The figure above shows the extraction efficiency curves for fresh ginger and the retail dietary supplement extracted using MeOH:H_2O. While the retail ginger sample was extracted in a short time, the extraction fresh ginger took longer, despite the use of identical solvents.

References

1. Krauss, Beatrice H. "Plants in Hawaiian Medicine" Honolulu: The Bess Press, 2001
2. Rhizoma Zingiberis. Commission on Dietary Supplement Labels. 2/16/2004. http://www.health.gov/dietsupp/fig3.htm