

液滴微流控法制备尺寸均匀可控的油茶籽油乳液

摘要:【目的】油茶籽油又名山茶油, 被称为“东方橄榄油”, 富含丰富的多不饱和脂肪酸和天然的茶多酚等物质, 因此被广泛地应用于食品、化妆品、医药品等领域。但是, 山茶油中的高不饱和脂肪酸易与氧气、水分、金属离子等发生反应而发生氧化, 这对其产品质量产生不良影响。此外, 油茶籽油较低的溶解度使其难以分散在其它基质中, 限制了山茶油的利用率。因此, 需要采用一种有效的包封策略以隔绝油茶籽油与氧化剂的接触, 增加其生物利用度。将油茶籽油进行乳化形成乳液是一种应用最广的包封递送载体。目前制备乳液的方法主要有高压均质法、超声乳化法和高速机械搅拌等方法。这些方法均能产生大批量的乳液, 但是所得到的乳液尺寸分布范围广、不均一, 严重影响其稳定性及产品的货架期。【方法】通过采用液滴微流控技术制备大小均一、尺寸可控的油茶籽油乳液。所用内相为压榨一级油茶籽油, 外相为含有 5 wt% 的吐温 20 (食品级) 水溶液, 借助微流控芯片, 在在流体界面张力、剪切力等相互作用下, 水油两相在剪切口相遇时被剪切成单个分散的小液滴。所使用的微流控芯片是流动聚焦型的 PDMS 材质的微流控芯片, 剪切口的尺寸为 50 μm 宽, 200 μm 长。为了得到油包水乳液, 所使用的芯片需要经过 PEG 化学改性, 使得 PDMS 表面为亲水性的。【结果】通过调节内外相流体的流速, 可以实现改变水包油茶籽油乳液的粒径。当外相的体积流速固定为 10 $\mu\text{l}/\text{min}$, 将内相的流速从 0.4 $\mu\text{l}/\text{min}$ 逐渐增加到 1.6 $\mu\text{l}/\text{min}$, 得到的液滴直径从 116.18 μm 逐渐增大到 128.23 μm , 说明液滴直径与内相流速正相关; 当内相的体积流速固定为 0.8 $\mu\text{l}/\text{min}$, 将内相的流速从 10 $\mu\text{l}/\text{min}$ 逐渐增加到 26 $\mu\text{l}/\text{min}$, 得到的液滴直径从 113.08 μm 逐渐减小 76.89 μm , 说明液滴直径与内相流速负相关。【结论】我们可以根据不同的应用需求制备各种大小且粒径均一的水包油茶籽油乳液液滴, 这为油茶籽油的包封递送提供了新的方法, 也为提高油茶籽油的生物利用率提供了技术支撑。

关键词: 油茶籽油; 乳液; 微流控技术; 尺寸均一

Preparation of controllable camellia seed oil emulsion by microfluidic method

Abstract: **【Objective】** Camellia oil seed oil, also known as camellia oil, is known as "Oriental olive oil", rich in polyunsaturated fatty acids and natural tea polyphenols and other substances, so it is widely used in food, cosmetics, medicine and other fields. However, the high unsaturated fatty acids in camellia oil are easy to react with oxygen, water, metal ions and other oxidation, which has adverse effects on the quality of its products. In addition, the low solubility of camellia seed oil makes it difficult to disperse in other substrates, which limits the utilization rate of camellia oil. Therefore, an effective encapsulation strategy is needed to isolate the contact of camellia seed oil from oxidant and increase its bioavailability. The emulsifying camellia seed oil to form emulsion is the most widely used encapsulated delivery carrier. At present, the methods of emulsion preparation mainly include high-pressure homogenization, ultrasonic emulsification and high-speed mechanical stirring. These methods can produce large quantities of emulsion, but the resulting emulsion size distribution range is wide and uneven, which seriously affects its stability and the shelf life of the product. **【Methods】** Prepare camellia oil oil emulsion with uniform size and controllable size. The inner phase is the first pressed camellia seed oil, and the outer phase is the Tween 20 (food grade) water solution containing 5 wt%. With the help of microfluidic chip, under the interaction of fluid interface tension and shear force, the two phases of water and oil are cut into a single scattered small liquid droplets when the shear mouth meets. The microfluidic chip used is a flow-focused PDMS material microfluidic chip, and the size of the shear port is 50 μm wide and 200 μm long. To obtain the oil-in-water emulsion, the chip used needs to be chemical modified by PEG to make the PDMS surface hydrophilic. **【Results】** By adjusting the flow rate of the internal and external phase fluid, the particle size of camellia oil seed oil emulsion can be changed. When the volume flow rate of the external phase is fixed to 10 $\mu\text{l} / \text{min}$, the flow rate of the internal phase is gradually increased from 0.4 $\mu\text{l} / \text{min}$ to 1.6 $\mu\text{l} / \text{min}$, the resulting droplet diameter gradually increases from 116.18 μm to 128.23 μm , indicating that the droplet diameter is positively correlated with the internal phase flow velocity; when the internal phase volume velocity is fixed to 0.8 $\mu\text{l} / \text{min}$, the flow rate of the internal phase is gradually increased from 10 $\mu\text{l} / \text{min}$ to 26 $\mu\text{l} / \text{min}$, and the resulting droplet diameter was gradually reduced by 76.89 μm from 113.08 μm , indicating that the droplet diameter was negatively correlated with the internal phase flow rate. **【Conclusion】** We can prepare the camellia seed oil emulsion droplets of various sizes and uniform particle sizes according to different application requirements, which provides a new method for the encapsulation delivery of camellia seed oil, and also provides technical support for improving the bioutilization rate of camellia seed oil.

Key words: camellia oil; emulsion; microfluidics; uniform size