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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 833-835

www.thepharmajournal.com
Received: 20-04-2023
Accepted: 26-05-2023

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Optimization of oil yield parameters of dragon fruit (*Hylocereus* spp.)

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Abstract
Dragon fruit is well known for its health benefits. It contains essential minerals, vitamins and is rich in fibre. The oil yield content of the dragon fruit (*Hylocereus* spp.) extract was analysed using Soxhlet apparatus with methanol and ethanol as solvents is varying amounts and different extraction times and varying temperature. The effects of temperature, time, dry fruit weight in grams, and solvent polarity on oil yields were studied. At temperatures at 60 °C, 65 °C, 68 °C, and 70 °C using 99.9% of methanol and 99.8% ethanol as solvents. The best conditions were chosen from initial studies and repeated to confirm the effects of the varying conditions. It was found that a temperature of 68 °C with methanol as the solvent yielded the greatest yield of 90.37% (w/w) for methanol and 87.75% (w/w) for ethanol.

Keywords: Dragon fruit, solvent extraction, soxhlet apparatus, ethanol, methanol

Introduction
Dragon fruit or pitaya is a tropical fruit belonging to the cactus family, Cactaceae (Le Bellec *et al*., 2006) [7]. Four types of dragon fruits are described: (i) white flesh with pink skin (*Hylocereus undatus*), (ii) red skin with purple flesh (*Hylocereus costaricenis)*, (iii) red flesh with pink skin (*Hylocereus polyrhizus*) and (iv) white pulp with yellow skin (*Hylocereus megalanthus*) (Mori *et al*., 2023) [8]. In India, dragon fruit cultivation was introduced during the late 1990s in Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Odisha, West Bengal, Andhra Pradesh and Andaman & Nicobar (Arivalagan *et al*., 2019) [1]. Karnataka has started initiatives to increase commercial production of dragon fruit, increasing cultivated area from 8-10 ha in 2012 to 5000ha over the next five years. Over 200 farmers in Gujarat's kutch region are now cultivating this dragon fruit for 800 ha. According to recent estimates, the dragon fruit production in India increased drastically to more than 12000 tons over an area of 3000-4000 ha in 2020 (Wakchaure *et al*., 2020) [11].
Dragon fruit *Hylocereus* spp. is a rich source of fibre and contains essential nutrients such carotene, calcium, fibre, vitamin B, vitamin C and phosphorus. The stem, flower, peel and pulp of pitaya fruit contain bioactive chemicals with antioxidant, antibacterial and anticancer properties (Satpute *et al*., 2020) [9]. The most abundant antioxidants in fruits are polyphenols and vitamin C, vitamin A, vitamin B, vitamin E and carotenoids which are present to varying amounts in different fruits. These polyphenols, most of which are flavonoids, are present mainly in ester and glycoside forms (Fleuriet and Macheix, 2003) [4].
Soxhlet extraction is traditional method used to extract volatile metabolites from plant material for quality and aroma-enhancing oil (Govender, 2010) [5]. This laboratory apparatus was first introduced by Franz von Soxhlet in 1879 (Soxhlet FV, 1879) [10]. Which is used to separate various compounds from the insoluble substance using different solvents. Soxhlet extraction is a simple and cost-effective method that uses fresh solvents in the sample phase to remove target compounds from the matrix.
The aim of this study was to extract the crude extract compound from dragon fruit using Soxhlet extraction method. The effect of solvent polarity on the oil yields were investigated. The solvent extraction using 99.8% methanol and 99.9% ethanol were executed in this study primarily to determine the ideal conditions that would yield the highest oil content.

Materials and Method
Fresh dragon fruit of *H. polyrhizus* obtained from a farm in Palakkad were used for the study, which was carried out in the Horticulture lab, School of Agricultural Sciences, Karunya Institute of Technology and Sciences, Coimbatore during the year 2022-23 (Fig 1).

Fig 1: Fresh Dragon Fruit (*H. polyrhizus*)

Solvent extraction of dragon fruit using Soxhlet apparatus
Sample preparation from Dragon fruit
The ripened fruit were chopped into small pieces and shade-dried at room temperature of 25 to 30 °C for 2 weeks. The dried samples were pulverized using a heavy-duty mixer grinder for ease of Soxhlet extraction. The powdered dragon fruit (60mg) (fig 3) was packed (fig 3) and stored at -4 °C and placed in an air-tight container for further process.

Fig 2: Powder of Dragon Fruit

Fig 3: Soxhlet Apparatus

Extraction Process
Extraction of the dragon fruit is carried out in a Soxhlet apparatus (Fig 3) using Ethanol (99.9%) and Methanol (99.8%) as solvents. The powdered dragon fruit was packed into a Soxhlet apparatus and extracted.

Evaporation of extracted solvent
After the extracted solvent obtained from the Soxhlet apparatus. The extracted was then placed to the rotary evaporator to remove the excess solvent.

Table 1: Constant extraction of dragon fruit (*H. polyrhizus*)

Drying period in room Temperature	14 days
Sample type	Powder
Drying method and Temperature	Shade drying in room temperature of 25-30 °C

Table 2: Variable extraction of dragon fruit (*H. polyrhizus*)

Solvents	Temperature °C	Weight of Samples (g)	Amount of Solvents (ml)	Time taken for Extraction (h)
Ethanol (99.9%)	60 °C	2	120	2
	60 °C	2	120	4
	65 °C	4	140	6
	70 °C	6	180	8
Methanol (99.8%)	68 °C	8	220	12
	68 °C	10	240	24

Table 1 and Table 2 shows the constant and variables used in the extraction of dragon fruit (*H. polyrhizus*) respectively.
The oil yield was computed as per,

Oil yield (%) = $W_1 / W_2 \times 100$

Where:
W_1 = Weight of dry extract
W_2 = Weight of dry plant

Results and Discussions
The study was conducted to evaluate the oil yield of dragon fruit using Soxhlet extraction with methanol and ethanol as solvents at different hours of extractions, temperature and number of solvents. Gatbonton *et al.* (2013) [6] reported that in every extraction the quality of crude extract is affected by the moisture content of the raw material. Hence, the dragon fruit samples were dried thoroughly for the Soxhlet extraction for ease of oil extraction.

Table 3: Percentage of oil yield using ethanol and methanol

Solvents	Hours	Amount of Solvent (ml)	Temperature °C	Samples (g)	Crude extract in (g)	Oil yield (%)
Ethanol	2	120	60 °C	2	1.21	60.5%
Ethanol	4	120	60 °C	2	1.55	77.5%
Ethanol	6	140	65 °C	4	2.83	70.75%
Ethanol	8	180	70 °C	6	4.69	78.16%
Methanol	12	220	68 °C	8	6.56	82%
Methanol	24	240	68 °C	10	8.12	81.2%

The crude extract and oil yield obtained using ethanol and methanol as solvents, under the conditions of varying temperatures, hours of extractions, quantity of solvents and amount of samples used are shown table 3. With 180 ml of ethanol as solvent, when extracted for 8 hours at 70 °C, the oil yield obtained was 78.16% (w/w). When 2 g of the sample was extracted with 120ml of ethanol at 60 °C for 4hours, an oil yield of 77.5% (w/w) was obtained (Table 3). This clearly shows that the oil yield is a combination of factors of temperatures, hours of extractions, quantity of solvents and amount of samples used. However, the quantity of crude extract obtained was found to increase steadily with increase in quantity of sample used.

When extract was carried out with 220ml of methanol as solvent, for 12 hours at 68 °C, the oil yield obtained was 82% (w/w). When 10 g of sample was extracted with 240ml of methanol at 68 °C for 24hours, an oil yield of 81.2% (w/w) was obtained. This reveals that using methanol for extraction gives more consistent and reliable oil yield in comparison with ethanol. Al-Sumri *et al.* (2016) [2] evaluated methanol extraction with dates seed and obtained the maximum oil yield and methanol as solvent with higher polarity. According to Ayoola *et al*., 2014 [3] the oil yield increased with increase in extraction time and there was considerable increase after 3 hours of extraction.

Table 4: Percentage oil yield using ethanol and methanol second run

Solvents	Amount of solvent (ml)	Hours	Temperature °C	Powder Samples (g)	Crude extract (g)	Oil yield (%)
Ethanol	140	6	65 °C	4	3.51	87.75%
Ethanol	180	8	70 °C	6	5.12	85.33%
Methanol	220	12	68 °C	8	7.23	90.37%
Methanol	240	24	68 °C	10	8.34	83.4%

During the second run, oil yield obtained with 220ml of methanol was 90.37% (w/w) at 68 °C in 12 hours, while ethanol yielded 87.75% (w/w) at 65 °C in 6 hours (Table 4). Considering all other factors, it was concluded that the 12 hours of methanol extraction is ideal for extraction of dragon fruit.

Conclusion

Several parameters are responsible for contributing to increased oil yield using Soxhlet extraction procedure. The study concluded that maximum dragon fruit oil yield was obtained under the following conditions of 68 °C temperature, for 12 hours, using 220 ml of methanol as solvent and 8 g of the sample. The oil yield of dragon fruit is highly dependent on the combination of factors viz., temperature, hours of extraction, type and quantity of solvent used and amount of samples used in the extraction. This study serves as a basis for further research in phytochemical screening and antioxidant activities of *Hylocereus* spp. Additional studies are suggested and required to isolate and identify the essential phenolic compounds present in each extract. As this research is still in its early phase, further investigation is needed for evaluation, isolation and quantification of the bioactive compounds in dragon fruit.

Acknowledgement

I would like to express my sincere gratitude to Karunya Institute of Technology and Science, for providing the laboratory and facilities, equipment and chemicals for carrying out my research successfully.

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