ABSTRACT

Muskmelon (*Cucumis melo*), is a highly perishable tropical fruit with yellow-orange coloured flesh. The fruit is rich in carotenoids, vitamins, polyphenols and antioxidants. These antioxidants are believed to provide numerous health benefits to human immune system and cardiovascular system. Muskmelon is highly perishable due to its climacteric nature. Improper storage and transport leads to enormous wastage owing to both quantity and quality loss at the time of surplus production. Therefore, the fruit needs to be processed further to improve its availability without wastage and also to make it available during off season. Conversion of muskmelon into convenient powder form could be easy to handle and could be used in the preparation of several products such as snacks, beverages, bakery goods and pastes.

The most common drying methods such as drum drying, spray drying, and freeze drying are employed for the production of fruit powders. As an alternative, foam mat drying can be used to produce powders. In this method the liquid product is whipped to form stable foam with the addition of suitable additives, dried by thermal means to form a thin porous honeycomb mat and disintegrated to yield a free-flowing powder.

For the production of muskmelon foam, three different foaming agents such as egg albumen (EA), soy protein (SPI) and whey protein (WPC) were selected. Carboxymethyl cellulose (CMC) was used as foam stabilizer to get stable foam. Initially optimization of foaming parameters was done using Box Behnken Design under Response Surface Methodology. The foaming parameters selected for optimization was concentration of foaming
agents, concentration of foam stabilizer and whipping time. The parameters were optimized when the responses yielded minimum foam density, maximum foam expansion and minimum foam drainage volume. The density of muskmelon foam was within the recommended range (0.3 to 0.6 g cm
\(^{-3}\)) associated with foam mat drying. Independent of the type of foaming agent, liquid separation was well observed in all samples without carboxymethylcellulose which indicated that influence of foam stabilizer on the foam stability. However, when foam stabilizer was not used, the liquid drainage was considerably low in case of whey protein concentrate than egg albumen and Soy Protein Isolate. Among the foaming agents, egg albumen and whey protein concentrate were found to produce lower foam density and higher foam expansion. The optimized values of egg albumen (11.59% of EA, 0.59% of CMC and 3.97 min of WT) soy protein isolate (8.95% of SPI, 0.53 of CMC and 5.02 min of WT) and whey protein concentrate (4.42% of WPC, 0.55 of CMC and 4.09 min of WT) treated sample were further selected for performing drying studies.

The muskmelon foam prepared using optimized foaming parameters were then dried in hot air dryer at a temperature of 50°C, 60°C and 70°C. The drying was also carried out for fresh unfoamed muskmelon pulp. The muskmelon powder obtained from foamed muskmelon pulp yielded a free flowing powder. However, a less porous sticky product was obtained from drying of unfoamed muskmelon pulp.

The moisture ratio values were fitted into selected drying models to determine the best fitting model. The drying of whey protein concentrate treated muskmelon pulp was well represented by Page model followed by Logarithmic and Midilli-Kucuk model. It was inferred that foaming of pulp and drying temperature had a predominant effect on
moisture diffusivity. Foaming improves the moisture diffusivity due to increased surface which in turn improved moisture removal. The higher drying temperature revealed high moisture diffusivity because at high temperature more energy was being provided for drying which increased the activity of water molecules and also the drying rate. The activation energy was found to be higher in case of foamed samples than unfoamed sample (16.34 kJ/mol) and the values were within the recommended range for food and agricultural materials.

The various physico-chemical properties of muskmelon powders were studied and the results were also correlated using statistical analysis. The properties like water activity, colour, bulk and tapped density, Hausner ratio and Carr index, water solubility index, hygroscopicity, ascorbic acid and beta carotene were studied. Studies on different properties inferred that the foaming improves structure, solubility and free flowing nature of muskmelon powder due to its open pore structure formed during whipping. Also the infrared analysis and microstructure analysis of the powder were performed. From this study, it was inferred that whey protein concentrate exhibited better powder properties and also confirmed that foam mat drying is a promising technique for the production of powdered products from fruit pulp. The approximate cost of production of foam dried muskmelon powder is about Rs. 745.98 per kg of muskmelon powder. The muskmelon powder was incorporated in model food systems such as ice cream and muffin to evaluate the consumer acceptance. The colour attribute in ice cream got higher score than the other sensory attributes. However, the incorporation of muskmelon powder in ice cream does not show any significant difference (p>0.05) in aroma, taste, texture and overall acceptability of the two types of ice creams. Similarly, in case of sensory evaluation of muffins, the texture was found to have significant difference from the control sample. However, other sensory
attributes such as colour, aroma, taste, and overall acceptability does not show any significant differences between control sample and sample with muskmelon powder. Thus, it was concluded that the incorporation of muskmelon powder in ice cream was highly acceptable by the consumers than muffins. Hence, it is concluded that foam mat drying is a highly promising technique for production of muskmelon powder using whey protein concentrate as foaming agent.