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Flash vacuum expansion in food processing

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1. Introduction: Nowadays, a busy lifestyle and poor diet common amongst people. Since we can spare only a few minutes in preparation of food, processed food is cult favourite. What we are consuming in our daily diet is its chemical free food? Our answer will be 'No'. There is a trend toward production of natural food with minimal quantities of chemicals involved in their production and preservation, as consumers expect the same amount of nutritional quality and quantity as in the fresh food (raw material). Hence it is necessity to evaluate emerging food processing alternatives which include, as far as possible, only physical processes for industrialization and preservation purposes.

Processing can be broadly classified into three main categories: Physical, biological and chemical processing. The physical processing can further be divided into thermal and non-thermal processing. Thermal processing is the most commonly used processing technique (Suh *et al*., 2003). There are three main temperature categories employed in thermal processing: Blanching, pasteurization and sterilization. However, it may degrade organoleptic, physical, and physicochemical properties, and the nutritional quality of processed product (Kubo *et al.,* 2013). Technique's alternative and complementary processes to thermal treatments are non-thermal processing. Non-thermal processing includes UV light, high-intensity light pulses, γ-irradiation, pulsed electric fields, radiofrequency electric fields, ohmic heating, microwave heating, ultrasound, high hydrostatic pressure, supercritical carbon dioxide, ozonation, and flash-vacuum expansion.

2. Flash Vacuum Expansion (FVE): FVE is a new process for treatment of plant materials which is applied before processing of plant material. Or it is a mild physical process - heat intake and pressure differences to disintegrate plant tissue (Paranjpe *et al.,* 2012). It improves

diffusivity of functional components and inhibits enzyme activity and also it enables the production of food products (juices and purees), which exhibit physicochemical and rheological attributes differing from those of products obtained by traditional schemes (i.e., blanching, crushing, and pulping). FVE consists of two stages. In the first, the raw material is heated by a steam flow in a chamber at 101.325 kPa; in the second, the plant material passes into an expansion chamber (2 to 5 kPa), where the disintegration of the tissues occurs. Briefly plant material introduced through a loading funnel into a horizontal stainless-steel steam-heating chamber equipped at its bottom with a rotating twin screw for both conveying and steam-heating the plant material at normal pressure through steam injection holes. Plant material exudates and condensed steam were collected through pipes at the heating chamber bottom and discarded. After having passed through the steam heating chamber, heated plant material (85 °C to 90 °C) are introduced through an airtight feeding pump into a large vacuum vessel where a vacuum (3 kPa) is generated by a vacuum pump cooled by a closed cooling water circuit. Instantly evaporated aromatic liquors (water phase) and essential oils are collected after passage into a condenser (Brat *et al.,* 2001).

3. Components of FVE:

- Steam heating chamber: Cylindrical stainless-steel (h= 175mm, v= 6L).
- Pneumatic valve actuator which connects steam heating chamber and vacuum expansion chamber.
- Vacuum expansion chamber (v= 37.5 L) where a rotating pulper or finisher installed to sieve the product on 1mm mesh.
- Between the heating and vacuum chambers, there is a large opening diameter ball valve (pneumatic ball valve) is present.
- This valve allows the passage of the material.
- This is operated by a rapid pneumatic actuator (80% opening of the valve in 1s).
- Liquid ring pump generates vacuum and capable of delivering a gas extraction rate of 4200 m^3/h.

- Used to provide vacuum pressures of 5 ± 1.2 kPa inside the chamber.
- Water vapor is condensed through a heat exchanger to limit the volume of gas suctioned by the vacuum pump.
- The vacuum pressure was recorded by a digital vacuum transducer.
- The equipment is then connected to two aseptic tanks for product and co-product recovery.
- The equipment is steam sterilized before process.
- The vacuum was broken through a vented sterilizing filter with an absolute air particle removal of 0.003µm.

4. Mechanism: Since FVE is not a well-known technology, it is prudent to first explain its basic mechanism. FVE is based on lowering the boiling point of water at reduced pressures. For example, at 1 kPa (absolute), the boiling point of water is 7 0 C. When plant material at 90 0 C is exposed to this pressure, the water in the plant material cells boils violently causing a 'flash'. The evaporating water takes the heat of evaporation from the plant material, cooling it in the process. The system equilibrates when the vapor pressure of water in the plant material matches the pressure of the chamber (boiling point at that pressure). This sudden and instantaneous evaporation causes a rupture of cell walls and is hypothesized to increase the concentration of cell components in the juice.

4. Applications: FVE find its huge application in following sectors like preparation of juice, wine, purees and extraction of essential oil.

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