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OPTIMIZING THE SPRAY DRYING PARAMETERS FOR POWDERED EGGS WITH 20% TAPIOCA STARCH ADDITIVE USING COMPUTATIONAL FLUID DYNAMICS SIMULATIONS

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Spray drying is one of the methods to preserve eggs. Addition of 20% tapioca starch to liquid egg prior to drying increases the shelf-life of the powdered product [1]. Although the said factor has been identified, production of powdered egg in a larger capacity is still a problem. One way to solve this predicament is to identify the optimum drying parameter that would produce a higher yield of dried eggs but retaining the quality parameter of the desired product, such as the moisture content and water activity [2]. The flow stability is the key issue in the optimization of the dryer operation. The patterns of airflow velocity, temperature and relative humidity (RH) inside the drying chamber are considered as the primary factors that influence the histories of the product. In this paper, the optimum drying parameters of a spray dryer was obtained by means of discrete phase modeling (DPM). This numerical model was used to determine the flow pattern of the continuous phase and tracked the particle histories of the disperse phase inside the drying chamber that produces powdered egg with 20% tapioca starch additive. Results in Table 1 indicate that the optimized inlet and outlet temperature parameters for the said operation condition were: 438K and 353K, respectively.

Table 1. Summary of Results

	Trial 1 (A/B)		Trial 2(A/B)		Trial 3(A/B)	
Air $Temp_{in}$	438K		453K		468K	
Air $Temp_{out}$	343K	353K	343K	353K	343K	353K
Particle $Temp_{out}$	399K	385K	401K	407K	414K	402K
Air Relative Humidity	1.93%	2.03%	1.82%	1.87%	1.75%	1.84%
EMC	4.75	4.55	4.82	4.87	5.01	4.82
Water Activity (a_W)	0.02	0.02	0.02	0.02	0.02	0.02

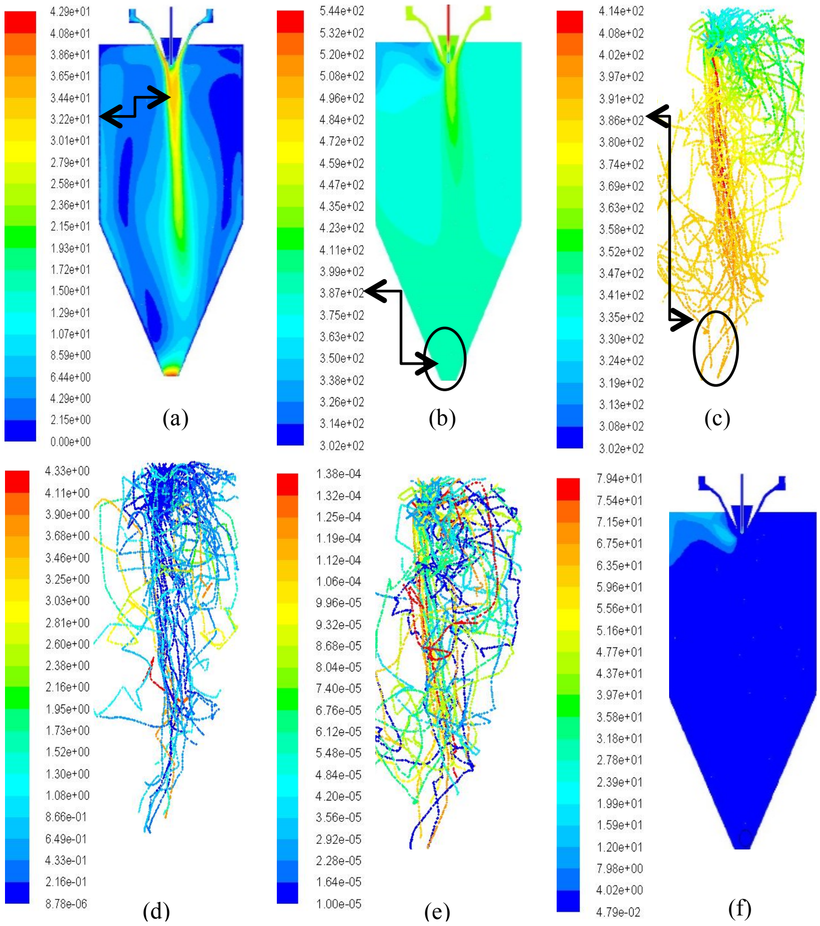

Figure 1: Numerical solutions of (a) air velocity, (b) air temperature, (c) particle temperature, (d) particle residence time, (e) particle diameter and (f) air relative humidity

Fig. 1 (a) shows the airflow velocity. As the liquid exits the injection nozzle, the air has a fast moving velocity at the central conical region of the drier enhancing the evaporation rate of water. In Figs. 1 (b) and 1 (c), the droplet temperature rises from the wet bulb to surrounding temperature and the particles are fully transformed into powder. A greater particle temperature than air outlet signifies that the feed was cooked rather than powderized. Fig. 1 (d) shows the lowest particle residence time of $8.78\text{x}10^{-6}$ s and the largest velocity of 32.2 m/s are found at the central core of the dryer. Fig. 1 (d) shows that drying is the fastest at the core region and eventually dries longer if the particles move closer to the wall. Fig. 1 (e) shows that larger particles are trapped in the core region and need a higher momentum to escape. The smaller ones have higher residence time and freely move outside of the core to adhere to the wall chamber leading to low production capacity. Fig. 1 (f) shows the moisture content of the powder is directly related to relative humidity of the outlet air [3]. At higher RH, the powder absorbs water and form liquid bridges between powder and particulates resulting in greater powder cohesion and mobility reduction. At low RH, the moisture experiences a high affinity with the surrounding air, allowing the liquid feed to experience faster rate of phase change. Fig. 1 (g) shows the outlet RH of 2.03%, the moisture content value of 4.55 and the water activity of 0.02, which are less than the given optimum preservation values.

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