Encapsulation efficiency and oxidative stability of electrostatic spray-dried powders

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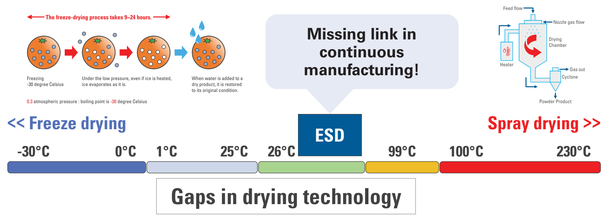
INTRODUCTION



- Electrostatic spray drying (ESD) is a low-temperature drying process (inlet: 80-150°C) relative to spray drying (SD) (Inlet: 150-230°C)[1, 2]
- ESD combines gas liquid atomization and electrostatic charge in a single-step process
- ESD takes place in an inert gas environment where O_2 is replaced by N_2
- ESD is suitable for processing heat and oxygen-sensitive materials, such as microorganisms, proteins, bioactive materials, encapsulated oils, and pharmaceuticals.
- Oil powders produced by ESD were compared with those produced by SD in terms of encapsulation efficiency and stability during storage.

AIM

To study the effect of ESD and SD on the physicochemical stability of encapsulated oil powders.

METHOD

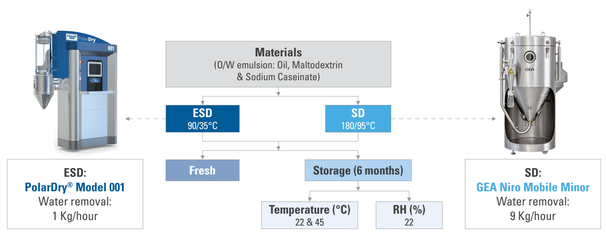


Fig. 1. Schematic presentation of drying experiment

	Inlet (°C)	*Outlet (°C)*	*Charge (kV)*
ESD	**90**	**35**	**10**
SD	**180**	**95**	**-**

Table 1. Drying parameters used in ESD and SD

RESULTS

Physicochemical properties:

- Oil emulsions were formulated to contain 20% to 80% (w/w) vegetable oil, encapsulated with maltodextrin and stabilized with sodium caseinate.
- Oil emulsions were dried by ESD (90°C inlet/35°C outlet) and SD (180/95°C).(Table 1)
- Physicochemical properties of fresh oil powders were measured and compared between ESD and SD at various oil loads (OL).

Powder	Moisture (%)	Water activity	Surface free fat (%)	Total oil (%)	Encapsulation efficiency (%)
ESD 90/35-20%OL	2.19 ± 0.58	0.157 ± 0.021	0.19 ± 0.06	19.94 ± 0.18	99.07 ± 0.33
ESD 90/35-50%OL	1.14 ± 0.25	0.166 ± 0.004	1.15 ± 0.39	49.88 ± 0.11	97.71 ± 0.77
ESD 90/35-80%OL	1.03 ± 0.18	0.188 ± 0.032	21.53 ± 0.49	79.89 ± 0.10	73.05 ± 0.59
SD 180/95-20%OL	0.41 ± 0.07	0.097 ± 0.002	0.62 ± 0.20	19.93 ± 0.05	96.89 ± 0.99
SD 180/95-50%OL	0.33 ± 0.05	0.011 ± 0.007	5.08 ± 0.45	49.89 ± 0.25	89.81 ± 0.96
SD 180/95-80%OL	1.03 ± 0.25	0.192 ± 0.009	37.41 ± 1.80	79.65 ± 0.45	53.03 ± 2.53

Table 2. Physicochemical properties of oil powders prepared by ESD & SD

- Irrespective of oil loads, moisture content in all powders was less than 3% and water activity below 0.20.
- ESD produced powders with greater encapsulation efficiency (EE) at 20, 50 and 80% oil load. Overall, the encapsulation efficiency drops with increasing oil load. For example, at 50% oil load, the encapsulation efficiency was more than 97% in ESD powders compared to less than 90% in spray-dried powders.

Storage stability

- Encapsulated oil powders were stored at 22 and 45°C and at 22% relative humidity for up to six months and analysed for surface free fat and oxidative stability.

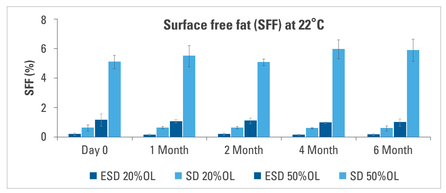


Fig. 2. Surface free fat content in ESD and SD powders during storage at 22°C and 22% RH

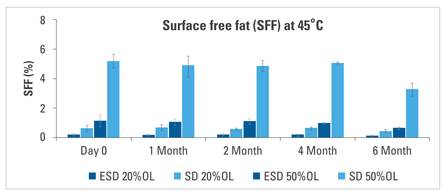


Fig. 3. Surface free fat content in ESD and SD powders during storage at 45°C & 22% RH

- Irrespective of oil loads, SFF content in fresh oil powders was lower in ESD powders compared to SD powders, and this trend was maintained during storage.(Fig. 1 & 2)

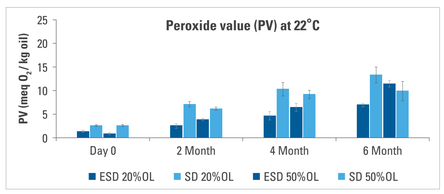


Fig. 4. Peroxide value in ESD and SD powders during storage at 22°C & 22% RH

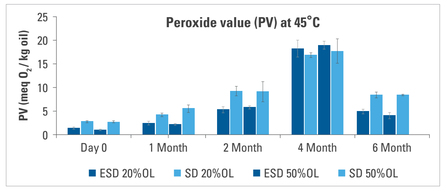


Fig. 5. Peroxide value in ESD and SD powders during storage at 45°C & 22% RH

- Peroxide value was lower in ESD powders compared to SD powders, irrespective of oil loads. Similar trends were observed during storage at 22 and 45°C and at 22% relative humidity.(Fig 4 & 5)
- Greater oxidative stability (lower PV) in ESD powders could be due to their lower SFF and higher EE.(Table 2)

CONCLUSIONS

- Low temperature ESD and traditional high heat SD were used to dry oil emulsions at various oil loads (20% to 80%, w/w).
- Moisture content in all powders was less than 3% and water activity below 0.20, irrespective of oil loads.
- Encapsulation efficiency (EE) was greater in ESD powders at 20%, 50% and 80% oil loads.

  Using 50% (w/w) encapsulated oil as an example, the EE was >97% in ESD powders compared to <90% in SD.

  This is explained by SFF which is approximately three times lower in ESD powders at 20% and 50% oil loads.
- During storage, peroxide values increased at 22°C and this was accelerated at 45°C, however, the increase was higher in SD powders compared to ESD.
- The low temperature electrostatic process offers a large scale spray drying solution applicable to heat and oxygen sensitive materials which would otherwise be exposed to thermal degradation and loss of quality and functionality.

REFERENCES

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2. Masum, A. K. M., Chandrapala, J., Huppertz, T., Adhikari, B., & Zisu, B. (2020).

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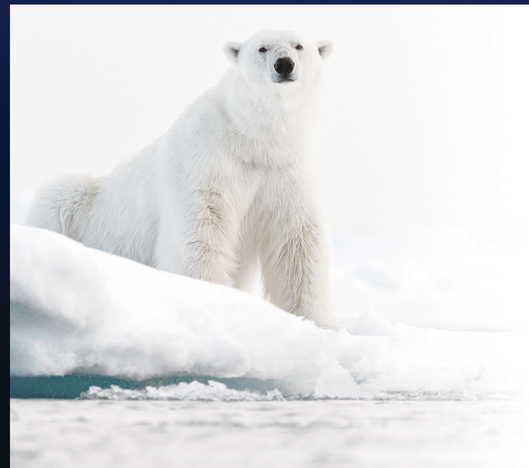


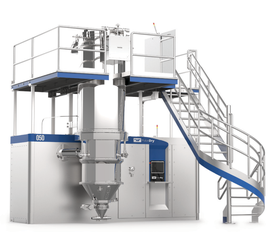
FLUID AIR PolarDry® SCALABLE ESD TECHNOLOGY


Model 0.1


Model 001


Model 004


Model 032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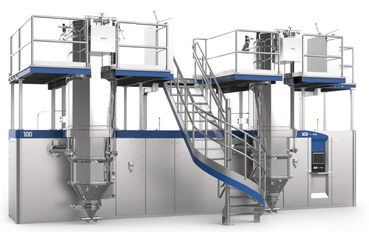
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