Transform Liquid-form Active Ingredient into Powder form with High Performance Liquid Carrier

1. Introduction

Several major active ingredients for human health, such as vitamin A/D/E/K, DHA/EPA, and natural herbal extracts are supplied in liquid form. Emulsified powder and microencapsulation were previously known as the major ways to provide better compatibility with other ingredients, but they don't meet the workability in the compression process. The powderization method of liquid ingredients with liquid carrier is offered, but there is no method to fulfill the adequate liquid carrying performance.
Tomita's FLORITE is a macro porous calcium silicate which has considerable liquid absorbency and retains liquid stably. We offer a practical powderization capability for liquid active ingredients that helps the development of a new combination use with other active ingredients.

2. Liquid carrier

For the model material of active liquid ingredients, fish oil was selected due to high viscosity liquid and commonly supplied in single component products.

FLORITE R and PS-200 were applied to tuna fish oil absorbing in the loading ratio of 1 to 2, and silicon dioxide (Silica) and a neutral type of magnesium aluminometasilicate (Silicate) were chosen as reference material because they are well-known liquid carriers. Liquid was absorbed in a closed mixing machine.

FLORITE is synthetic calcium silicate which has a petaloid structure with developed deep and large macro pores on the particle. Such pores are applicable to liquid carrying, binding, stabilizing and solid dispersion.
FLORITE R is standard product of the FLORITE brand, and it is a light powder with high liquid absorbency. FLORITE PS-200 is a fine granular type, and it has spherical form offering higher flowability. Both FLORITE R and PS 200 are much higher liquid absorbency than reference materials.

In the case of Silicon dioxide (Silica), both powder and granule form have well flowability, but granule forms are more dense granules with better flowability. In the case of magnesium aluminometasilicate (Silicate), both powder and granule forms showed higher liquid absorption compared to silicon dioxide.
Considering these results, this study shows their Liquid absorbency neither depends on particle size nor specific surface area.

Table 1 Powder form： FLORITE/ Magnesium aluminometasilicate / Silicon dioxide

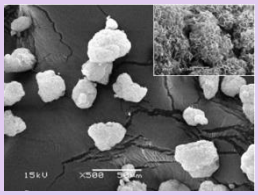
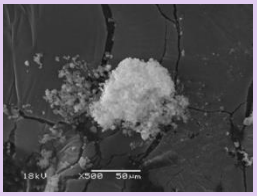
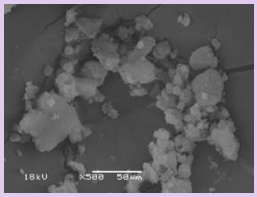
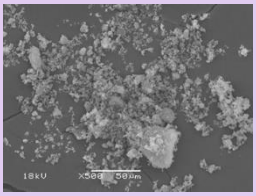
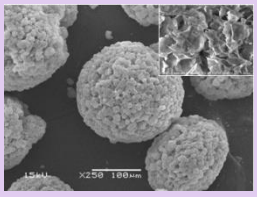
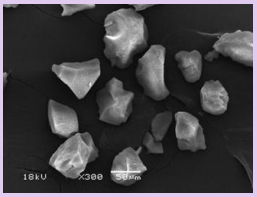
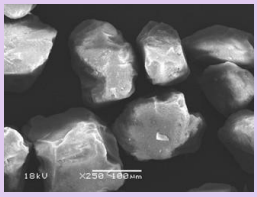
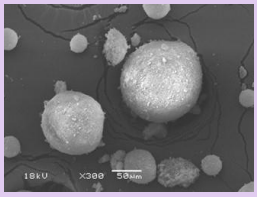
	FLORITE R	Silica A	Silica B	Silicate E
Appearance				
Median particle size	30 μm	3 μm	24 μm	14 μm
Oil absorbing capacity	4.6 mL/g	2.5 mL/g	2.2 mL/g	2.5 mL/g
Specific surface area	140 m²/mL	200 m²/mL	350 m²/mL	370 m²/mL
Loose bulk density	0.07 g/mL	0.09 g/mL	0.06 g/mL	0.15 g/mL
Repose angle	47 deg.	41 deg.	41 deg.	42 deg.

Table 2 Granule form： FLORITE / Magnesium aluminometasilicate / Silicon dioxide

	PS200	Silica C	Silica D	Silicate F
Appearance				
Median particle size	130 μm	62 μm	167 μm	140 μm
Oil absorbing capacity	4.8 mL/g	2.4 mL/g	2.1 mL/g	2.6 mL/g
Specific surface area	210 m²/mL	300 m²/mL	370 m²/mL	420 m²/mL
Loose bulk density	0.07 g/mL	0.31 g/mL	0.28 g/mL	0.17 g/mL
Repose angle	40 deg.	35 deg.	28 deg.	37 deg.

3. Liquid powderizing study

Fish oil carrying powder with each material in the loading ratio of 1 to 2, was prepared in a closed mixing machine. Although the fish oil powders with other silica/silicate were showing a yellow color which came from the original fish oil, FLORITE doesn't change its color. Color change occurs significantly in granule type liquid carriers. It suggested that FLORITE retains the oil inside deep particles. Regarding flowability, in the case of FLORITE, flowability was stable even after carrying the fish oil, on the other hand, in the case of silica/silicate, flowability was decreased. The deterioration of flowability is caused by bled fish oil on the particle surface. It means that FLORITE can retain the oil surely inside the particles. Especially in the case of granule type silica, retaining fish oil stably was difficult and fish oil was bled out and aggregated remarkably.

Table 3 Characteristics of the fish oil powder with powder type liquid carrier

	FLORITE R	Silica A	Silica B	Silicate E
Appearance				
Color	white	off-white	off-white	yellowish
Loose bulk density	0.33 g/mL	0.37 g/mL	0.67 g/mL	0.52 g/mL
Repose angle	43 deg.	52 deg.	43 deg.	53 deg.

Table 4 Characteristics of the fish oil powder with granule type liquid carrier

	FLORITE PS-200	Silica C	Silica D	Silicate F
Appearance				
Color	white	yellowish	yellowish	yellowish
Loose bulk density	0.39 g/mL	0.60 g/mL	0.55 g/mL	0.48 g/mL
Repose angle	36 deg.	Unmeasurable	Unmeasurable	53 deg.

4. Difference in liquid carrying mechanism

Specific surface area which we measured using nitrogen gas adsorption was uncorrelated with the liquid absorbency as shown in Table 1 and 2. It seems that the macro structure of the particle increases liquid absorption.

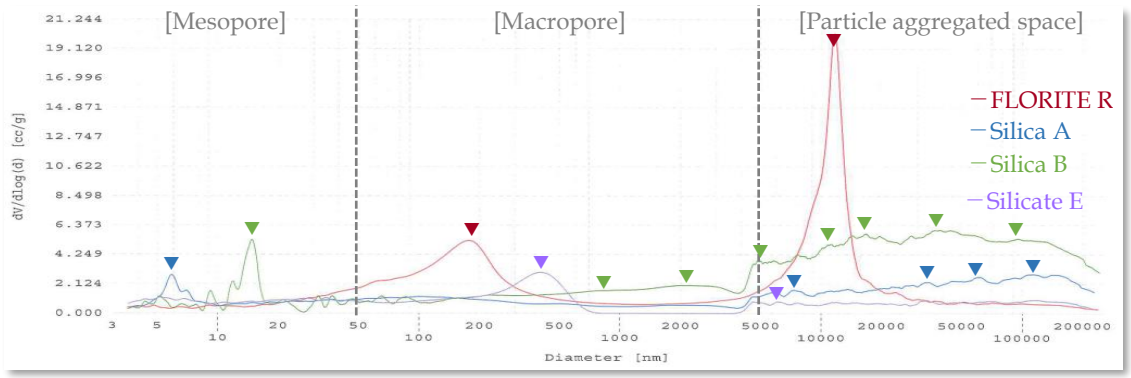
We measured the larger pore size distribution on the surface using mercury porosimetry analysis. FLORITE and silicate E have macropores from 50 to 5000 nm, other silicas have mesopores up to 50 nm. Silicate F has both. In all liquid carriers, particle aggregated space(interspace) was detected.

The total space of mesopore and macropore shows liquid absorbing capacity, it is proven that FLORITE has the highest capacity in all carriers.

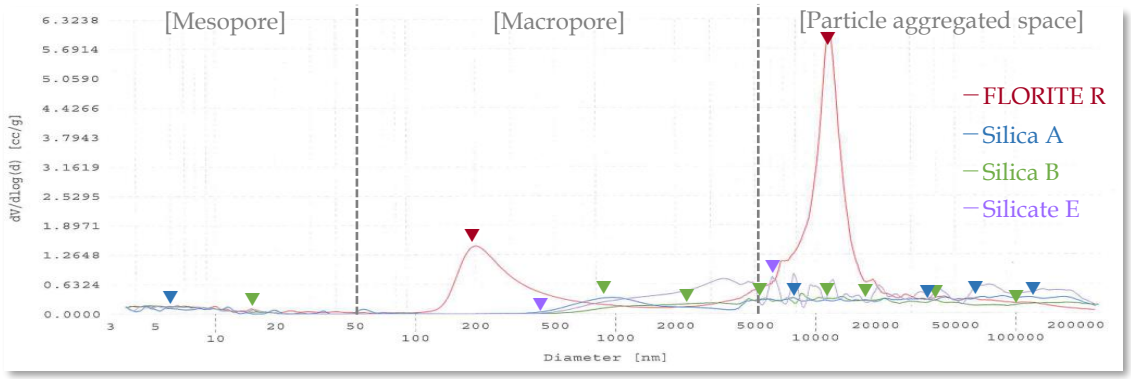
In the case of FLORITE, fish oil was filled into macropores shown in the pore volume decreasing, however a lot of empty pores remain. Silicate E also absorbed the oil into macropores, although almost all pores were filled up. Silicate F captures the oil in both macropores and mesopores, however mesopores disappeared after absorption.

Fig. 1 Pore size distribution by mercury porosimetry of powder type liquid carrier

[Original]



[Fish oil powder]

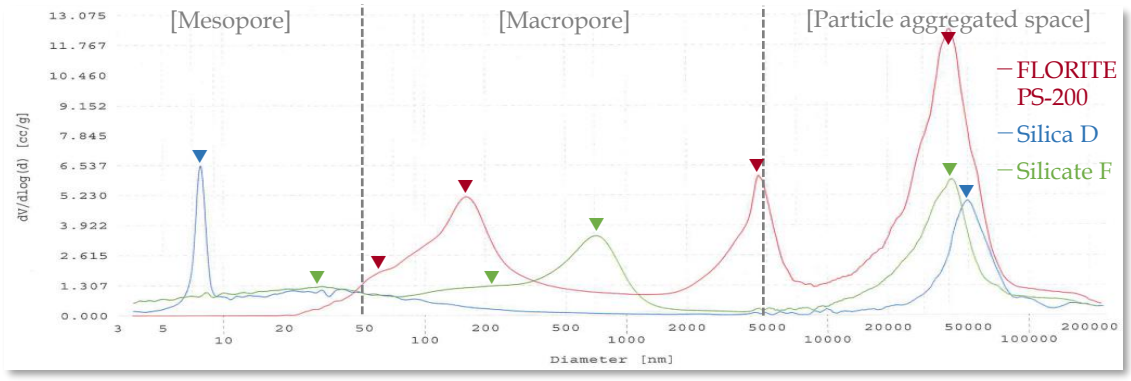


On the other hand, all silicas hold the oil in mesopores and exhausted all pores at once. Their mesopores volume is limited, and it supposes that the part of fish oil was stored in other space.

In focusing on interspace of particles, the space was decreased in all silicas through the absorption. It means the fish oil was retained in not only pores but also interspace and supported that the oil made aggregation between particles spoiling the flowability. In FLORITE and the silicates, didn't show remarkable decreasing such space, the particles were still separated independently.

Fig. 2 Pore size distribution by mercury porosimetry of granule type liquid carrier

[Original]



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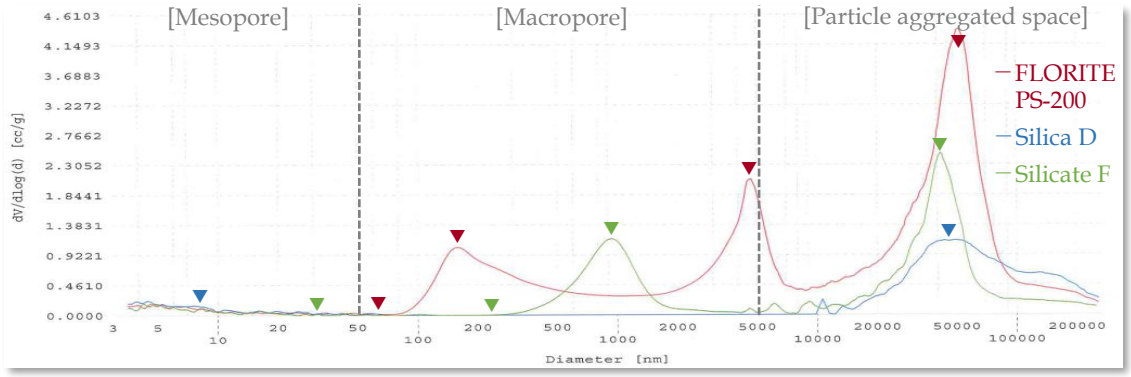

5. Conclusion

FLORITE, high performance liquid carrier, offers other options in formulation design with liquid-form active ingredients to solid dosage form. It supports stable liquid retaining, easy to handle and no concern of product hue. It improves consumer access to desirable ingredients.

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