ZoomEssence's Patented Low-Temperature Zooming® Encapsulation Technology Improves Volatile and Flavor Retention of Black Pepper Oleoresin

Black pepper is a common flavor component of many food systems. Formulators often use refined black pepper oleoresin in order to deliver consistent black pepper flavor to commercially produced foods. Because black pepper oleoresin is a complex spice containing many sensitive aroma constituents, which may degrade or volatilize during commercial food manufacturing, it is often challenging to capture the full-bodied, authentic flavor consumers expect. A patented low-temperature spray drying process known as Zooming® enables full retention of volatile flavor compounds, allowing formulators to use less yet deliver stronger, authentic black pepper flavor. When compared to black pepper flavor produced using a traditional plating process, DriZoom® black pepper showed, on average, 46% higher volatile retention in the powder and about 10 times stronger flavor in fried and baked applications.

Black pepper is one of the most widely used spices in the food industry. Black peppercorns are used to create refined oleoresins, which are liquids that deliver black pepper flavor into food. These oleoresins are characterized by their piperine and volatile aroma contents, where a 40:20 specification indicates 40% piperine and 20% volatile aroma compounds. This ratio provides a full-bodied, true flavor profile. Without the volatile aroma compounds, the woody/piney/citrus organoleptic characteristics will be lost, leaving only pungent, spicy, tingling trigeminal impacts.[1]

The primary constituents of black pepper and their vapor pressures are listed in Table 1. Without a proper process, many of these compounds may be lost during the manufacture of oleoresin powder. Further, oleoresins are sensitive to light, heat and oxygen. Without proper protection, the volatile aroma compounds may evaporate during storage and depending on the application, during processing. This may result in pigment discoloration and ultimately changes in the organoleptic profile.

Converting black pepper oleoresin liquid into a powder format helps in the application of oleoresins into a variety of food processes. This conversion can take place by spray drying or plating. [2,3] The latter is the most common, as it is a convenient process that involves the liquid compound being mixed with the plating agent (high-surface area particulates, including salt, sugar, maltodextrin, porous starch and porous silica). The oleoresin adsorbs on the surface of the carrier materials to form a powder product.

Traditional spray drying involves high temperatures, which can be destructive to many of the volatiles. Therefore, the food industry is reluctant to adapt spray drying due to its higher cost and marginal improvement in aroma retention.

ZoomEssence commercialized a patented low-temperature spray drying technology known as Zooming, which retains delicate actives by avoiding thermal degradation. The Zooming process spray dries liquids at around 110ºF, an unprecedented low operating temperature of spray drying.[4]

The resulting powders, DriZoom, exhibit a dense matrix and larger particle diameters that protects actives during storage and food processing, allowing for efficient delivery of active flavor components. This enables the formulator to significantly reduce flavor use rates while delivering great flavor experience.

Compound	Descriptor	Vapor Pressure (mmHg @ 25°C)
a-Thujene	Woody, green, herbal	4.77
a-Pinene	Dry, woody, resinous-piney	4.75
d-3-Carene	Woody, fir, citrus	3.72
Camphene	Harsh, camphoraceous, coniferous	3.00
b-Pinene	Woody, piney	2.93
Sabinene	Woody, piney, citrus	2.63
Myrcene	Woody, balsam, spice	2.29
Phellandrene	Woody, peppery, spice	1.57
Limonene	Citrus, piney, fresh	1.55
p-Cymene	Citrus, fresh	1.46
a-Terpinolene	Fresh, woody, sweet, pine, citrus	1.13
b-Thujene	No-reference found	1.07
g-Terpinene	Woody, terpenic	1.07
d-Elemene	Sweet, herbal, lavender, woody	0.03
a-Cubebene	Herbal, waxy	0.01
b-Caryophyllene	Woody, spice, clove	0.01
a-Humulene	Woody	0.01
d-Cadinene	Thyme, herbal, woody, dry	0.01

Table 1: Example aroma compounds in black pepper oleoresin. Order is based on elution time from gas chromatography.

Materials and Methods:

DriZoom and traditionally plated black pepper oleoresin powders were compared via Gas Chromatography Mass Spectrometry (GCMS) analysis and internal panel sensory evaluation.

The DriZoom ingredient was produced by combining water, maltodextrin, modified food starch and the oleoresin, forming an emulsion targeting 8.5% black pepper oleoresin in the final powder. The emulsion was then spray dried using the Zooming process.

The plated ingredient was prepared by combining 8.5% black pepper oleoresin with 91.5% salt flour. The ingredient was blended for 15 minutes using a planetary mixer bowl with paddle attachment.

Solvent extraction (a proprietary three-component process) was used to analyze the volatile compounds in the powders using GCMS.

Solid Phase Microextraction (SPME) was used to analyze the volatile compounds in the food products, where 0.5 grams of product was placed in a 20 mL SPME vial. The vial was incubated for 1 minute under orbital shaking at 158ºF. A 30-minute adsorption SPME process followed by 3-minute desorption into the GCMS inlet was followed/conducted.

To prepare the hush puppies, DriZoom and plated powders were each mixed into the hush puppy base batter, which contained cornmeal, leavening, salt and egg. The 40-gram nuggets of this mixture were fried in oil at 325ºF for 3.5 minutes. After frying, the hush puppies were cooled down to 70ºF, vacuum packed and frozen at -10ºF for at least 24 hours. Before evaluation, the frozen hush puppies were warmed in a 350ºF conventional oven until they reached an internal temperature of 165ºF.

To prepare the biscuits, DriZoom and plated powders were each mixed into biscuit dough, which contained flour, fat, milk, leavening and salt. Sixty-three mm disks with 50mm thickness were baked in a conventional oven at 375ºF for about 21 minutes. The biscuits were then cooled and frozen at -10ºF for at least 24 hours. Before evaluation, the frozen biscuits were warmed in a 350ºF conventional oven until they reached an internal temperature of 165ºF.

Results and Discussion:

Volatile retention in fresh DriZoom and plated powders was analyzed by solvent extraction. Figure 1 shows significant higher volatile retention of DriZoom over the plated powder. It is believed that the primary contributing factor to volatile evaporation in the plating process is the expansion of the total surface area.

Vapor pressure is a strong indicator on rate of evaporation for a volatile compound. The vapor pressures of the volatiles in Figure 1 ranges from 4.77 to 0.01 mmHg approximately correlating to the elution time in the GC column. For a-pinene, with 4.75 mmHg vapor pressure, the plate retention is 72% less than that of DriZoom, and for caryophyllene, with 0.1 mmHg vapor pressure, the plate retention is 11% lower. On average, over observed aroma compounds, the plate retention is 46% less than that of DriZoom.

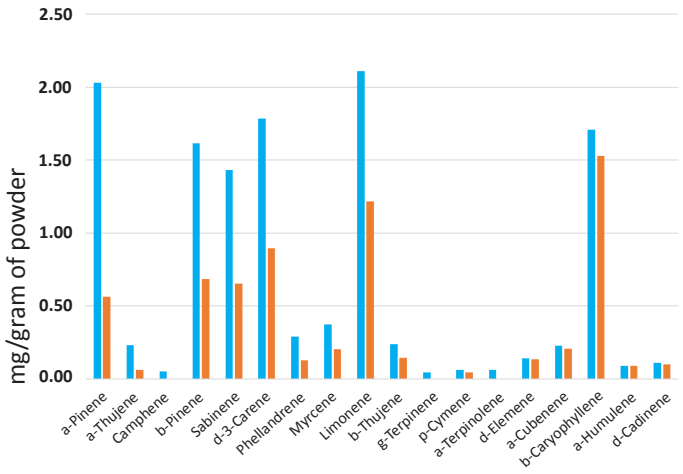

Figure 1: Volatile retention in DriZoom (blue) and plate (orange) powders, with both formulated to 8.5% black pepper oleoresin. Solvent extracts of volatiles were injected for GCMS analysis, and the concentration was normalized based on internal standard, dodecane.

This data suggests that the DriZoom ingredient contains more full-bodied, authentic black pepper flavor than the plated powder. To further validate this observation, the powders were tested in high heat applications, such as hush puppies (deep frying) and biscuits (baking). SPME and sensory analysis was then conducted.

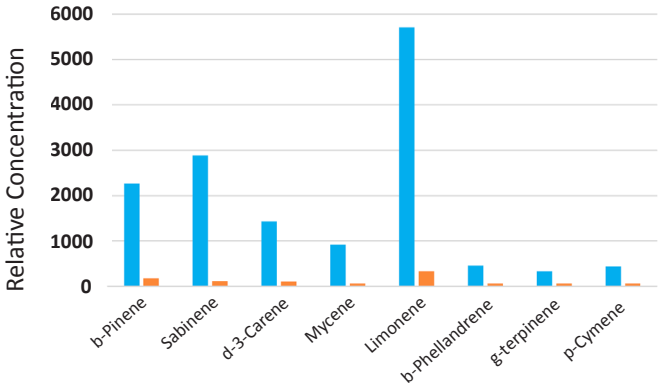

Figure 2: SPME comparison of aroma actives in DriZoom (blue) and plated (orange) black pepper oleoresin powders prepared in hush puppy batter after frying.

The SPME analysis of the hush puppies showed that using plated powder resulted in loss of most flavors in the fried products (Figure 2). On average, the retention using the plated ingredient was 88% lower than that of the DriZoom ingredient, based on peak areas of GCMS.

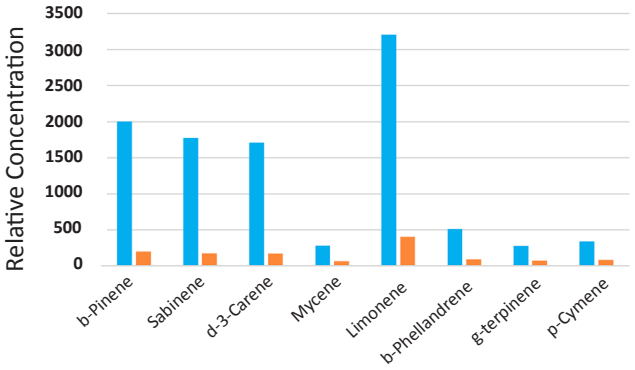

Figure 3: SPME comparison of aroma actives in baked biscuits using DriZoom (blue) and plated (orange) black pepper oleoresin.

The SPME analysis of the biscuits showed that the increased exposure time to the elevated temperatures encountered during baking significantly reduced the presence of most black pepper oleoresin volatiles (Figure 3). Aroma was almost undetectable in the biscuits made with the plated black pepper oleoresin powder.

Fresh powder	Hush puppies	Biscuits
46%	88%	95%

Table 2: Improved retention of DriZoom compared to plated, in powder and in food products.

In both food prototypes, fried and baked, DriZoom demonstrated significant improvement in process tolerance and retained approximately 46–95% more aroma and flavor than the plated powder (Table 2).

Sensory analysis of the food products showed that the black pepper aromatics were perceived as the highest in the DriZoom flavored samples.

Conclusion:

The patented low-temperature spray drying process known as Zooming delivers high retention of volatile aroma compounds in black pepper oleoresin, as compared to the commonly used plating process. This retention is transferred to high-heat food applications, allowing for a finished product with full-bodied, authentic black pepper flavor.

References:

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3. Teixeira, B.N., et al., Synthesis and Characterization of Nano-Encapsulated Black Pepper Oleoresin using Hydroxypropyl Beta-Cyclodextrin for Antioxidant and Antimicrobial Applications. *Journal of Food Science*, 2013. 78(12): p. N1913–N1920
4. Beetz, C.e.a., Methods and apparatus for low heat spray drying, *USPTO*, Editor. 2011.

ZoomEssence

For more information, please contact:
Steve DeCorte, SVP Sales
sdecorte@zoomessence.com

ZoomEssence Inc.
1139 Victory Place
Hebron, KY 41048
844-DRI-ZOOM