KEY ATTRIBUTE COMPARISON
OF BLUEBERRY INGREDIENT FORMATS

blueberries
Inspiring Possibilities™

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INTRODUCTION

The following information is intended to compare key nutrients, anthocyanins, and phenolics, and sensory attributes of different blueberry ingredient formats to inform product development.

OBJECTIVE

The objective of this project was to create an educational guide that provides comparison information on a wide array of blueberry ingredients of different formats, comparing them to fresh blueberries and each other. The testing performed was on key nutrients, anthocyanins, and phenolics, and sensory attributes.

FRESH BLUEBERRIES

Definition and Processing

Fresh blueberries are harvested, precooled, sorted, and packed for delivery.

Use Case

Due to their minimal processing, fresh blueberries have a relatively short shelf life. They are very delicate and will get crushed in industrial equipment. For these reasons, fresh blueberries may be better suited for applications with gentle processing such as hand placement and foodservice applications such as salads or parfaits.

INDIVIDUALLY QUICK FROZEN BLUEBERRIES

Definition and Processing

Fresh ripe blueberries are harvested, precooled, washed, and individually quick frozen.

Use Case

Frozen blueberries are fantastic substitutes in most cases for fresh berries in a plant environment.

Once cooked, it is hard to distinguish frozen berries from fresh berries. They provide the burst and juiciness of a fresh berry while having a long shelf life. Because they are free flowing, as opposed to case frozen or straight pack blueberries, frozen berries can usually be processed frozen. frozen berries provide the individual fresh fruit identity, so any formulation in which fruit identity is important would benefit from frozen.

FREEZE-DRIED, WHOLE BLUEBERRIES

Definition and Processing

Fresh or frozen blueberries get flash-frozen, then placed in a vacuum chamber for moisture removal (typically 2% maximum moisture); may be further processed (i.e., for powder, pieces). The vacuum lowers the pressure, allowing water to evaporate at a lower temperature. This creates dried food with less heat application than a traditional drying process. Freeze-drying creates a crunchy blueberry and preserves its shape.

Use Case

Freeze-dried berries are great for applications in which shelf-stable, low-moisture, and no-sugar-added blueberries are needed. Freeze-dried berries are perfectly suited for lower water activity foods, and they will absorb moisture in higher water activity foods. Freeze-dried blueberries hydrate well, rapidly becoming plump and flavorful. They are a good option for cereals and granolas, popcorn, and dry grocery meals. The ingredient cost can be higher per pound; however, they are extremely lightweight. This means that there are many more freeze-dried berries per pound, which is advantageous for cost in use.

INFUSED-DRIED WHOLE BLUEBERRIES

Definition and Processing

Infused-dried blueberries are made from fresh or frozen blueberries infused with syrup and dehydrated. They are then further processed to dried fruit specification using heat, creating raisin-like, chewy blueberries. Blueberries are much lower in sugar than the grapes used for raisins, which means that even when dried, blueberries naturally have a higher water activity, preventing shelf stability. The syrup infusion adds sugar, which lowers the water activity (<0.65), creating a product that is shelf stable. Common infusions used include sucrose (sugar infused) and apple (apple juice infused). A neutral oil such as sunflower oil is typically added to help with flow and prevent sticking.

Use Case

Infused-dried blueberries can be used in many products, from dry muffin mixes to trail mixes to frozen meals. They can contribute to a chew and a caramel-like texture. They are higher in moisture than berries dried with other methods (moisture: 11%-16%, although lower moisture is available) and will contribute to moisture migration if matched with ingredients with a lower water activity. Added sugar will need to be declared in the nutrition facts panel.

MICROWAVE/VACUUM-DRIED, MICRODRIED,® WHOLE BLUEBERRIES

Definition and Processing

Microwave drying is another form of low-heat drying process that can be used on blueberries (MicroDried, 2022). The berries are microwaved under a vacuum to lightly heat them, which dries them faster than ambient temperature. This process preserves more nutrients and fresh flavor than traditional drying methods. They are darker and crunchier than freeze-dried berries and have a different flavor.

Use Case

These berries are best when used in similar applications as freeze-dried. However, they are crunchier, darker, and slightly slower to hydrate than freeze-dried. Microwave/vacuum-dried blueberries are less sour and have more defined flavor than freeze-dried blueberries. They add texture to low water activity products. Like freeze-dried blueberries, they stand out visually due to their dark color. Formats include whole berries, fragments, and powder.

INFRARED-DRIED, INFIDRI,™ POWDER

Definition and Processing

Infrared-dried blueberry powder is blueberry purée subjected to infrared waves that specifically target water molecules. This creates a powder that has a different color and flavor than other drying methods.

Use Case

Infrared-dried powder maintains vibrant color and flavor. It can dissolve, but the solution will retain some particulates because it is made from whole berries, including insoluble skin and fiber. Consider in applications where whole fruit incorporation is important or as an impactful topical seasoning.

DRUM-DRIED, POWDER

Definition and Processing

Drum-dried powder is made from blueberry purée with the addition of other functional and flavoring ingredients such as starch and natural flavors. The puréed mixture is spread thinly on heated barrels, and the heat evaporates the water, creating a sheet of dried product. The sheet is then ground to the desired particle size.

Use Case

This blueberry powder can be less expensive than other powder formats, making it a great option for lowering the cost of a product while still delivering substantial flavor, color, and nutrition. It can be dissolved in liquids. There is an opportunity to add custom flavors in drum-dried powders, providing flexibility in crafting the exact blueberry flavor needed for a product.

PURÉE, SINGLE STRENGTH

Definition and Processing

Fresh blueberries get pressed, heat/enzyme treated, pasteurized, and packaged. Purée typically is stored frozen. Seeds can be removed to create a seedless purée as well. Seedless purées can have fewer particulates and a slightly less bitter taste.

Use Case

Purée products are great for higher moisture applications. It imparts both color and flavor differently based on application. Color can vary based on pH and base colors in the application. For example, a white ice cream base will maintain the right blue/purple of the purée well, while a yellow cake may see slight greening with purée. Purée also provides fiber and can be used functionally to thicken products.

JUICE, SINGLE STRENGTH

Definition and Processing

Blueberry juice is the liquid that is collected from pressing whole blueberries. It is typically pasteurized to prevent microbial contamination. It is dark blue/purple and has a thin viscosity.

Use Case

Blueberry juice can be used in similar ways to purée. However, it will not thicken a product due to the missing fiber. It will give flavor and color to a product and can be used instead of water to hydrate products such as cakes or oatmeal. Similar to the purée, the pH and background color of the formula will affect the color of the juice.

ESSENCE

Definition and Processing

Essence is a by-product of the juice and purée concentration process consisting of the volatiles that flash off during heating. The volatiles are captured in a carrier, typically alcohol. Essences are aromatic and elicit more aroma than taste on the tongue. It is a light, delicate, clear liquid that can be added to food to enhance aroma.

Use Case

Essences are best used in products that do not go through a heat process. Applying heat to an essence will cause the volatiles to flash off, and impact will be lost. Consider using in applications such as dressings and sparkling water.

POMACE

Definition and Processing

Blueberry pomace is derived from the solids left over from the juice pressing process. It is rich in fiber and comes in frozen or dried forms. This fiber is still very blue due to the retained color of blueberry skin.

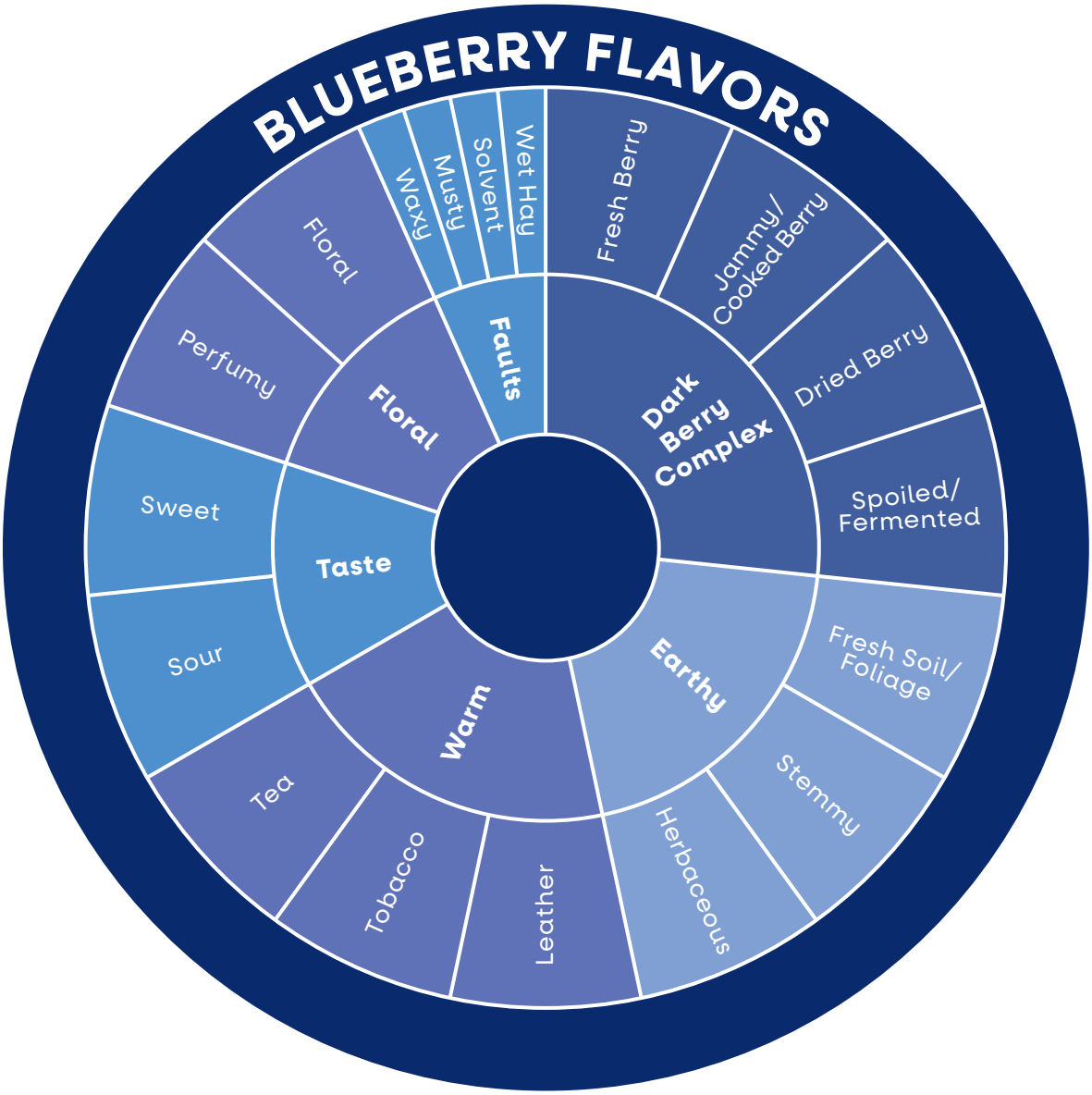
Use Case

Blueberry pomace is a great way to add fiber, anthocyanins, and blue/purple particulates to a product. Consider adding to applications such as oatmeal, cookies, bread, and more.

BLUEBERRY FLAVOR WHEEL

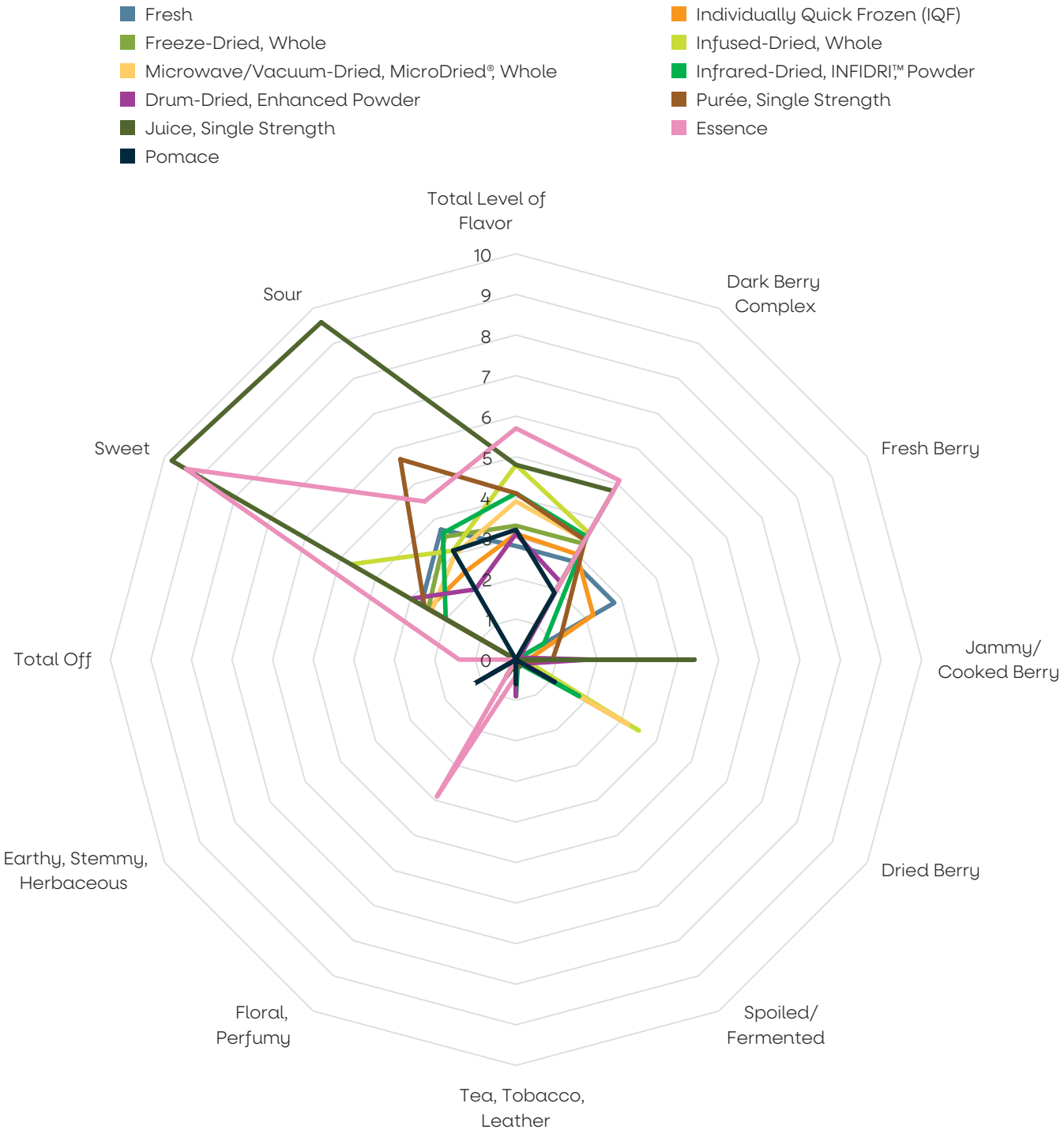
In addition to the blueberry ingredients' varying functional and nutritional benefits, they also exhibit many different flavor profiles. When choosing a blueberry product, a developer must consider not only the technical impact on a product but also the flavor contribution.

The flavor wheel is a figure that shows the lexicon a trained sensory panel used to evaluate the blueberry ingredients studied. This flavor wheel can be used to evaluate the blueberry flavor profile of blueberry ingredients and finished products containing blueberries.



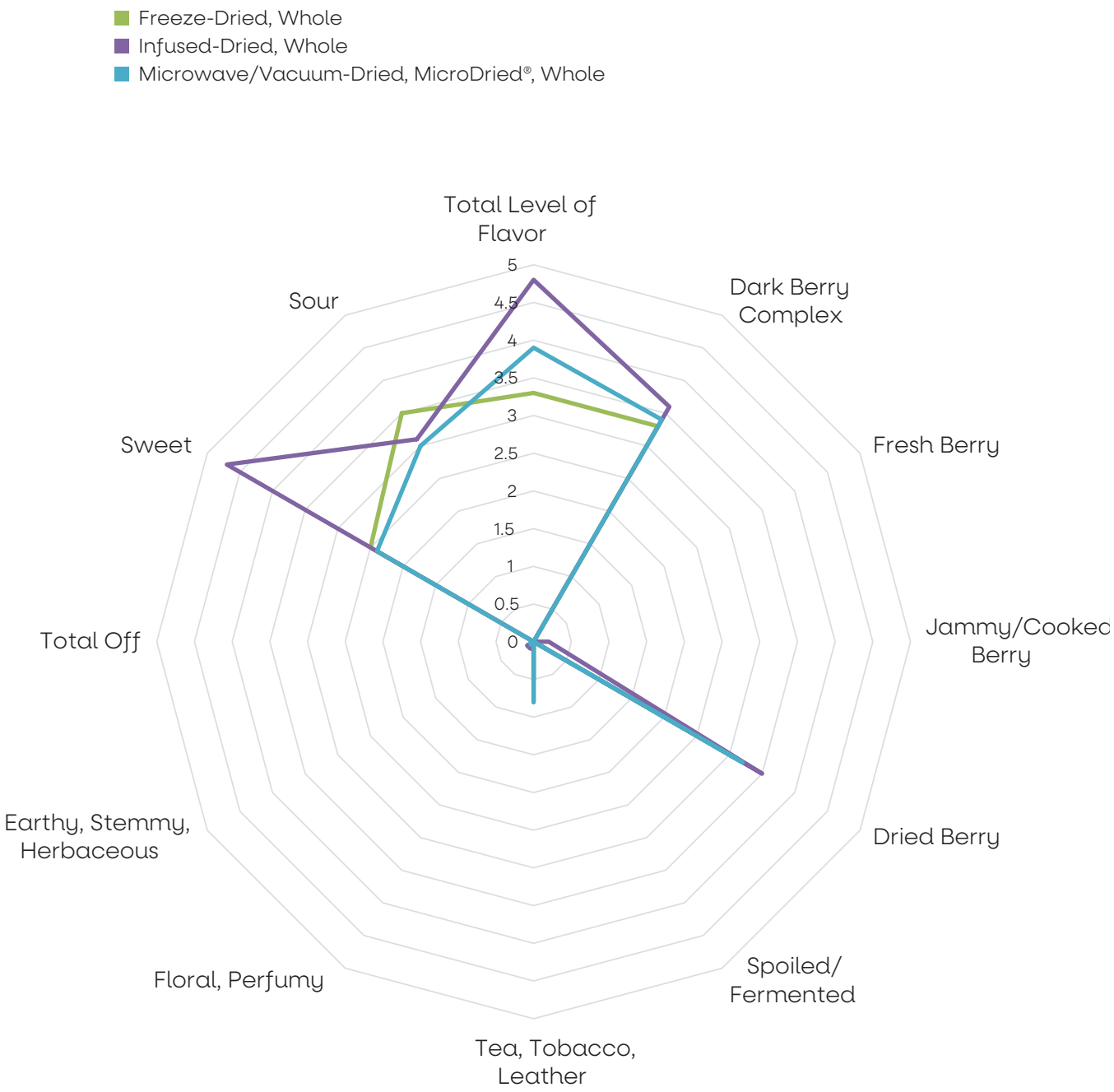
The National Food Lab, 2022

ALL BLUEBERRY INGREDIENTS FLAVOR PROFILE



The National Food Lab, 2022

DRIED WHOLE BLUEBERRY INGREDIENTS FLAVOR PROFILE

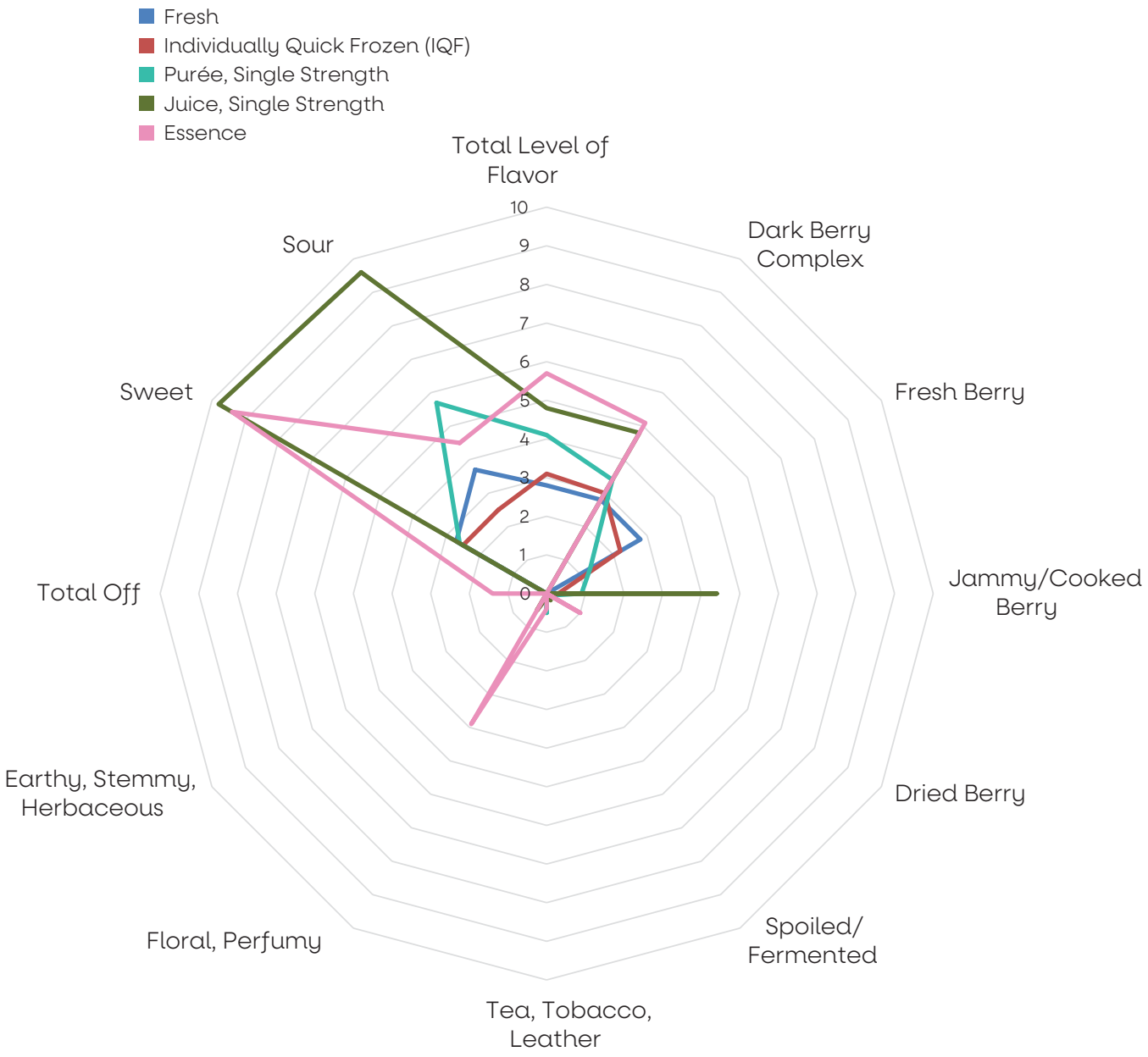


The National Food Lab, 2022

POWDERED BLUEBERRY INGREDIENTS FLAVOR PROFILE

The National Food Lab, 2022

HIGH-MOISTURE BLUEBERRY INGREDIENTS FLAVOR PROFILE



The National Food Lab, 2022

BLUEBERRY COMPARISON TABLE

Table 1 outlines the relative quantity of a blueberry ingredient needed to provide the comparative quantity of a nutrient found in a 148g serving of fresh blueberries. For example, the table shows that 11.58g of pomace provides a similar amount of fiber to what is found in 148g of fresh blueberries.

Blueberry Ingredient Comparisons to Fresh					
Ingredients	**Servings of Blueberries**	**Vitamin C** (Eurofins, 2022)	**Fiber** (Eurofins, 2022)	**Total Anthocyanins** (Medallion Labs 2022)	**Total Phenolics** (Eurofins, 2022)
	Grams of Product equal to 1 serving (148g) Fresh Blueberries *directional comparison	Grams of Product to Provide the equivalent Vitamin C of 1 serving (148g) of Fresh Blueberries	Grams of Product to Provide the equivalent Fiber of 1 serving (148g) of Fresh Blueberries	Grams of Product to Provide the equivalent Anthocyanins of 1 serving (148g) of Fresh Blueberries	Grams of Product to Provide the equivalent Phenolics of 1 serving (148g) of Fresh Blueberries
Fresh	148.00	148.00	148.00	148.00	148.00
Frozen	155.00			188.10	180.69
Freeze-Dried, Whole	19.16	104.87	53.53	12.25	15.38
Infused-Dried, Whole	80	402.26			52.76
Microwave/Vacuum-Dried, MicroDried®, Whole	18.50	196.10			22.52
Infrared-Dried INFIDRI™ Powder	25.64	158.46		126.51	28.77
Drum-Dried, Powder	69.57	338.10			50.29
Purèe, Single Strength	148.00				231.94
Juice, Single Strength	Not whole fruit derived, non-applicable	406.42		104.58	54.62
Essence	Not whole fruit derived, non-applicable				
Pomace	Not whole fruit derived, non-applicable	286.28	11.58	62.75	31.48

Grey cells were not tested

BLUEBERRY INGREDIENT NUTRIENTS

Table 2 outlines the comparison on a 100g basis. The purpose of this data is to guide product developers during their ingredient selection and testing processes. Each blueberry ingredient provides a different nutrient profile, allowing developers to choose the right ingredient or combination of ingredients to meet their nutrition objectives.

Blueberry Ingredient Nutrients per 100g					
Ingredients	**Servings of Blueberries**	**Vitamin C** (Eurofins, 2022)	**Fiber** (Eurofins, 2022)	**Total Anthocyanins** (Medallion Labs, 2022)	**Total Phenolics** (Eurofins, 2022)
	Grams of Product equal to 1 serving (148g) of Fresh Blueberries *directional comparison	Milligrams Vitamin C per 100g of Blueberry Ingredient	Grams Fiber per 100g of Blueberry Ingredient	Milligrams Anthocyanins 100g of Blueberry Ingredient	Milligrams Phenolics per 100g of Blueberry Ingredient
Fresh	148.00	5.30	4.63	106.00	210.00
Frozen	155.00			83.40	172.00
Freeze-Dried, Whole	19.16	7.48	12.80	1280.00	2020.00
Infused-Dried, Whole	80	1.95			589.00
Microwave/Vacuum-Dried, MicroDried,® Whole	18.50	4.00			1380.00
Infrared-Dried, INFIDRI,™ Powder	25.64	4.95		124.00	1080.00
Drum-Dried, Powder	69.57	2.32			618.00
Purée, Single Strength	148.00				134.00
Juice, Single Strength	Not whole fruit derived, non-applicable	1.93		150.00	569.00
Essence	Not whole fruit derived, non-applicable				
Pomace	Not whole fruit derived, non-applicable	2.74	59.2	250.00	987.00

Grey cells were not tested

*Claiming Servings of Fruit

Only blueberry products that maintain the whole blueberry may be used to claim a “serving of fruit” on a final package. The expectation of food labels is that they are “truthful and not misleading” according to the Code of Federal Regulations title 21. Claiming a serving of fruit without the entire fruit in a product is seen as misleading. For example, juice is the liquid portion of the berry squeezed out of the solid portion and cannot be used to claim a serving of fruit. However, there is an opportunity to claim a serving of juice if 1 cup/240mL is used in a product. Puréed blueberries may be used to claim a serving of fruit because the entire blueberry remains in the purée.

All data represents the analyses of select samples and is intended to provide directional and comparative guidance only

CONCLUSION

Blueberries are visually attractive and adaptable fruits that provide numerous nutritional, functional, and flavor benefits to food products.

Blueberries are readily available in many forms—fresh, frozen, dried whole fruit and powders, dried and infused with sugar or fruit juice, purées, juice, essence, and pomace, each with a variety of processing and specification considerations.

Every blueberry ingredient performs differently depending on the application, and it is important to methodically test samples in application when developing a new product. Even similar types of ingredients may taste and function differently depending on the processing of the ingredient and the ingredients in the final formulations. Each blueberry ingredient format has its own strengths and functionalities that make them stand out in numerous types of food product. From bakery to savory, anthocyanins to vitamin C, fresh berry flavor notes to jammy cooked berry flavor notes, blueberry ingredients are powerful tools that can transform formulations and create delicious products that product developers and consumers enjoy.

Detailed information on testing methods, ingredients, results, and recommended next steps can be found linked in the appendix.

BLUEBERRY INGREDIENTS TESTED

Fresh Blueberries

Frozen Blueberries

Freeze-Dried, Whole

Infused-Dried, Whole

Microwave/Vacuum-Dried, Whole

Infrared-Dried, Powder

Drum-Dried, Powder

Purée, Single Strength

Juice, Single Strength

Essence

Pomace

All values are based on analysis of single types of ingredients. There may be some slight naturally occurring variations across brands and varieties.

BLUEBERRY INGREDIENTS NUTRITION PANELS

FORMAT	CALORIES	CALORIES FROM FAT	CALORIES FROM SAT FAT	PROTEIN	CARBOHYDRATES
Fresh	50.05 kcal	3.04 kcal	— kcal	.68 g	14.19 g
Frozen	51.61 kcal	5.81 kcal	— kcal	— g	12.26 g
Freeze-Dried, Whole	346.55 kcal	18.09 kcal	1.53 kcal	4.5 g	88.1 g
Infused-Dried, Whole	359.5 kcal	9.9 kcal	1.8 kcal	2.2 g	85.3 g
Microwave/Vacuum-Dried, MicroDried®, Whole	346.55 kcal	18.09 kcal	1.53 kcal	4.5 g	88.1 g
Infrared-Dried, INFIDRI™ Powder	396.46 kcal	58.32 kcal	— kcal	5.02 g	78.1 g
Drum-Dried, Powder	332.99 kcal	38.79 kcal	2.61 kcal	2.42 g	83.52 g
Purée, Single Strength	57.33 kcal	3.06 kcal	.36 kcal	.82 g	12.76 g
Juice, Single Strength	64.74 kcal	9.54 kcal	.36 kcal	.82 g	12.76 g
Essence	42 kcal	— kcal	— kcal	— g	— g
Pomace	378 kcal	27 kcal	5.76 kcal	9.34 g	78.32 g

FORMAT	TOTAL DIETARY FIBER	DIETARY FIBER	TOTAL SUGARS	ADDED SUGAR	FAT
Fresh	2 .7 g	2.7 g	10.14 g	— g	0.34 g
Frozen	2.58 g	2.58 g	8.39 g	— g	.65 g
Freeze-Dried, Whole	14.59 g	14.59 g	60.55 g	— g	2.01 g
Infused-Dried, Whole	10.4 g	2.91 g	74.6 g	48 g	1.1 g
Microwave/Vacuum-Dried, MicroDried® Whole	14.59 g	14.59 g	60.55 g	— g	2.01 g
Infrared-Dried, INFIDRI™ Powder	20.19 g	20.19 g	51.36 g	— g	6.48 g
Drum-Dried, Powder	14.3 g	14.3 g	34.16 g	11.15 g	4.31 g
Purée, Single Strength	— g	3.3 g	8.39 g	— g	.34 g
Juice, Single Strength	— g	— g	8.39 g	— g	1.06 g
Essence	— g	— g	— g	— g	— g
Pomace	72.34 g	72.34 g	2.05 g	— g	3 g

(per 100g)

BLUEBERRY INGREDIENTS NUTRITION PANELS (CONTINUED)

FORMAT	SATURATED FAT	MONO FAT	POLY FAT	TRANS-FATTY ACID	CHOLESTEROL
Fresh	— g	— g	— g	— g	— mg
Frozen	— g	— g	— g	— g	— mg
Freeze-Dried, Whole	.17 g	.29 g	.89 g	— g	— mg
Infused-Dried, Whole	.2 g	.6 g	.2 g	.1 g	— mg
Microwave/Vacuum-Dried, MicroDried®, Whole	.17 g	.29 g	.89 g	— g	— mg
Infrared-Dried, INFIDRI™, Powder	— g	— g	— g	— g	— mg
Drum-Dried, Powder	.29 g	.22 g	.88 g	— g	— mg
Purée, Single Strength	.04 g	.06 g	.24 g	— g	— mg
Juice, Single Strength	.04 g	.06 g	.24 g	— g	— mg
Essence	— g	— g	— g	— g	— mg
Pomace	.64 g	.59 g	1.6 g	— g	— mg

FORMAT	VITAMIN A - IU	VITAMIN A - RAE	VITAMIN B3 - NIACIN EQUIV	VITAMIN B6	VITAMIN B12
Fresh	— IU	— mcg	— mg	— mg	— mcg
Frozen	— IU	— mcg	— mg	— mg	— mcg
Freeze-Dried, Whole	328.31 IU	16.42 mcg	2.85 mg	.32 mg	— mcg
Infused-Dried, Whole	— IU	— mcg	— mg	— mg	— mcg
Microwave/Vacuum-Dried, MicroDried®, Whole	328.31 IU	16.42 mcg	2.85 mg	.35 mg	— mcg
Infrared-Dried, INFIDRI™, Powder	— IU	24 mcg	— mg	— mg	— mcg
Drum-Dried, Powder	10.66 IU	.53 mcg	— mg	— mg	— mcg
Purée, Single Strength	78.4 IU	3.92 mcg	— mg	— mg	— mcg
Juice, Single Strength	78.4 IU	3.92 mcg	— mg	— mg	— mcg
Essence	— IU	— mcg	— mg	— mg	— mcg
Pomace	— IU	7.85 mcg	— mg	— mg	— mcg

(per 100g)

BLUEBERRY INGREDIENTS NUTRITION PANELS (CONTINUED)

FORMAT	VITAMIN C	VITAMIN E - ALPHA- TOCO	FOLATE	PANTOTHENIC ACID	CALCIUM
Fresh	9.46 mg	— mg	— mcg	— mcg	6.76 mg
Frozen	2.58 mg	— mg	— mcg	— mcg	6.45 mg
Freeze Dried Whole	58.97 mg	3.47 mg	36.48 mcg	.75 mg	36.48 mg
Infused Dried	— mg	— mg	— mcg	— mg	34.2 mg
Microwave/Vacuum-Dried, MicroDried®, Whole	58.97 mg	3.47 mg	36.48 mcg	.75 mg	36.48 mg
Infrared-Dried, INFIDRI™, Powder	43.54 mg	— mg	— mcg	— mg	116.53 mg
Drum-Dried, Powder	70.51 mg	.18 mg	— mcg	— mg	101.44 mg
Purée, Single Strength	7.16 mg	1.85 mg	— mcg	— mg	19 mg
Juice, Single Strength	7.16 mg	1.85 mg	— mcg	— mg	19 mg
Essence	— mg	— mg	— mcg	— mg	— mg
Pomace	— mg	— mg	— mcg	— mg	178 mg

FORMAT	COPPER	IRON	MAGNESIUM	MANGANESE	PHOSPHORUS
Fresh	— mg	0.27 mg	— mg	0.34 mg	— mg
Frozen	— mg	.19 mg	— mg	.15 mg	— mg
Freeze-Dried, Whole	.75 mg	1.7 mg	36.48 mg	2.04 mg	72.96 mg
Infused-Dried	— mg	.64 mg	— mg	— mg	— mg
Microwave/Vacuum-Dried, MicroDried®, Whole	.35 mg	1.7 mg	36.48 mg	2.04 mg	72.96 mg
Infrared-Dried, INFIDRI™, Powder	— mg	4.25 mg	— mg	— mg	— mg
Drum-Dried, Powder	.02 mg	2.33 mg	2.32 mg	.01 mg	3.48 mg
Purée, Single Strength	— mg	.6 mg	9 mg	— mg	20 mg
Juice, Single Strength	— mg	.6 mg	9 mg	— mg	20 mg
Essence	— mg	— mg	— mg	— mg	— mg
Pomace	— mg	18.5 mg	— mg	— mg	— mg

(per 100g)

BLUEBERRY INGREDIENTS NUTRITION PANELS (CONTINUED)

FORMAT	POTASSIUM	SELENIUM	SODIUM	ZINC
Fresh	74.32 mg	— mcg	— mg	— mg
Frozen	51.61 mg	— mcg	— mg	— mg
Freeze-Dried, Whole	468.14 mg	.61 mcg	6.08 mg	.97 mg
Infused-Dried, Whole	— mg	— mcg	— mg	— mg
Microwave/Vacuum-Dried, MicroDried®, Whole	468.14 mg	.61 mcg	6.08 mg	.97 mg
Infrared-Dried, INFIDRI™, Powder	673.74 mg	— mcg	69.25 mg	— mg
Drum-Dried, Powder	.77 mg	.54 mcg	17.3 mg	.02 mg
Purée, Single Strength	110 mg	— mcg	2 mg	— mg
Juice, Single Strength	110 mg	— mcg	2 mg	— mg
Essence	— mg	— mcg	— mg	— mg
Pomace	267 mg	— mcg	7 mg	— mg

(per 100g)

blueberries
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