Processing for Natural Flavors: Cucumber, Melon, Watermelon

The importance of accurate species typing, collection, storage and processing in producing FTNF flavors

by John Boddington, Treatt plc

Consumer demand for appealing, distinctive, yet all-natural products has led flavor ingredients manufacturers to develop new FTNF (from the named food) natural distillates. With today's consumers now the driving force behind the flavor industry, research continues into the production of high quality products from completely natural ingredients. Among the increasingly popular fresh flavors, cucumber, melon and watermelon — now used in products ranging from yogurts to flavored alcoholic beverages — are becoming key players in the market.

The quality and success of any fruit flavor begins with the raw material. Fruit picked at exactly the right time and stored in the correct manner should reach manufacturers in peak condition. Herein, we will take a closer look at harvesting, storage and production processes employed to create high quality cucumber, melon and watermelon flavors.

The Cucurbitaceae Family

The genus *Cucumis* L. (Cucurbitaceae) is extensive and includes two major commercial vegetable crops — cucumbers and melons. Relatively recent introductions to the New World, melon (*Cucumus melo*) and watermelon (*Citrullus lanatus*) both originated in Africa about 5,000 to 6,000 years ago. The cucumber (*Cucumus sativus* L.) originated in India 3,000 years ago, and cultivation began in Europe between the 9th and 12th centuries.

Classification: The naming and identification of cucumbers, melons and watermelons is a controversial subject — one that has caused confusion amongst scientists for decades. The naming of melons, in particular, is complex (T-1). The main problem is that day-to-day terminology does not always match what is categorically correct. For example, the muskmelon (*C. melo* var. *reticulatus)* is invariably referred to as the cantaloupe melon in the United States. However, in other parts of the world, the true cantaloupe melon is a rough-skinned variety that is easily differentiated from the netted muskmelon. Until there is a unified global melon vocabulary, it is likely that these discrepancies will continue.

With so many product differentiations, it is hardly surprising that the flavor industry is under increased pressure to develop authentic melon flavors that resemble the actual fruit.

In a far simpler situation, *C. sativus* is the only known cucumber species grown commercially. While the structure and growth habit of the numerous varieties of cucumber differ only slightly, they show considerable variation in flavor volatiles and so cannot be used interchangeably. Such variations include the ratio of *trans*-2-

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Melon classification **T-1**

Latin Name	Description	US Terminology	EU Terminology	Comments
Cucumis melo var. *reticulatus*	All varieties have a musky scent and skin with raised, netted pattern	Cantaloupe, musk melon, nutmeg melon, rock melon	muskmelon	The cause of much confusion — in the United States, muskmelons are frequently called cantaloupes
	Gold netting, orange flesh	Cantaloupe, muskmelon	muskmelon	
	Gold netting, green flesh	Ogen, galia	Galia	
Cucumis melo var. *inodorous*	Good storage melons with unscented skin that can be smooth or corrugated — but never netted	Honeydew, winter Melon	Honeydew	
	Cream/white skin, green flesh	Honeydew, winter melon, Christmas melon	Honeydew	
	Yellow skin, cream flesh	Canary, Spanish, casaba	Spanish, (Honeydew in the United Kingdom)	
	Yellow skin, orange flesh	Crenshaw		
Cucumis melo var. *cantaloupensis*	Highly fragrant, with thick, rough skin — no netting	Rarely grown	Cantaloupe	The true Cantaloupe melon
	Grey/beige skin, orange flesh	Rarely grown — French charentais	Charentais, chaca, French or Italian	

nonenal to *trans*-2-, *cis*-6-nonadienal: the presence, or lack of, various alcohols; and the impact of the more volatile C6 aldehydes such as hexanal.

Getting it Just Ripe

When producing FTNF flavors it is essential that the raw material is in peak condition. A key parameter is ripeness. Manufacturers, and indeed fruit growers, use different methods to determine ripeness depending on the fruit.

For melons, the skin aroma is the best indicator — the majority of field fruit must have a fruity and musky smell before harvesting can commence. In the case of cantaloupe, skin color between the raised netting is also useful — orange/gold being a good sign of ripeness. One of the best indicators of watermelon ripeness — apart from cutting it open — is to thump the fruit. A dull sound denotes ripeness, whereas a higher, metallic response reveals that the fruit is not mature and will not have developed its full potential of flavor volatiles. The salad cucumbers we eat are in fact always immature. Harvesting is based on size and color and occurs just before the end of the fruit's growing period. Over-large/yellow cucumbers are too ripe for use.

Storage and Handling

It is not always possible to process fruit immediately. FTNF ingredient manufacturers therefore need to secure an extensive range of temperature and humidity controlled storage facilities to ensure that the flavor volatiles present in the raw materials are not lost.

The handling of cucumbers and watermelons must not damage the desirable enzymatic flavor system of the fruit. Both contain lipoxygenases, which will only become active once the flesh is cut or broken. For flavor preservation, it is essential that the fruit are not chilled, but stored at temperatures approaching 10°C, otherwise these enzymes may start to become inactivated. The flavor of watermelon is said to intensify when stored under these conditions for around a week.

Cantaloupe melons continue to ripen after harvesting and, when stored in close proximity, ethylene build-up can lead to an almost "runaway" ripening effect. Commercially, it is recommended that cantaloupes are stored chilled — especially during transportation. However, manufacturers have found these cold conditions to have a detrimental effect on the

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overall fruit flavor. The only solution for FTNF manufacturers, therefore, is to pick the melons ripe and process immediately. In an even more extreme case, freezing of any sort is detrimental to the flavor of cucurbits. In all cases, of course, cross contamination between fruit in controlled atmosphere storage must also be avoided.

Fresh Flavor Chemistry

FTNF flavor developers must work with nature to maximize the quality and quantity of the collected fruit volatiles. Primarily, manufacturers must ensure that the correct species and variety of fruit has been selected, the right level of fruit maturity has been achieved and ideal storage conditions are in place. Since none of these fruit (cucumber, melon or watermelon) are cooked prior to eating, human taste buds are able to detect and reject, alien notes in FTNF distillates and extracts caused by processing.

Exposure to heat in the first instance encourages interaction and breakdown of amino acids and sugars within the fruit, generating a range of volatile artifacts. Telltale signs of excessive heating are amino acid breakdown products such as dimethyl sulfide and methional. In a worst-case scenario, fresh cucumbers and watermelons exposed to overheating can be converted into FTNF extracts reminiscent of cooked cabbage or, worse, dirty dishwater.

Excessive temperatures can also destroy the true flavor volatiles present in the fruit — particularly true for cucumber and melon. As soon as flavor volatiles are released they are naturally subjected to hydrolysis — breakdown catalyzed by the presence of water. As a guide, a 10°C rise in temperature doubles the reaction rate; so, the higher the processing temperature, the more enhanced this hydrolytic phenomenon. In both cucumbers and cantaloupe melons, aldehydes and esters are key flavor volatiles that are highly susceptible to hydrolysis.

Whether by distillation, solvent extraction, membrane technology or some other means, the production of an FTNF flavor requires the material fruit to be puréed so that the natural flavor can be more easily captured. Fruit are unfortunately not static systems, and when puréed, even at low temperatures an incredibly complex cascade of enzymatic and non-enzymatic reactions occur.

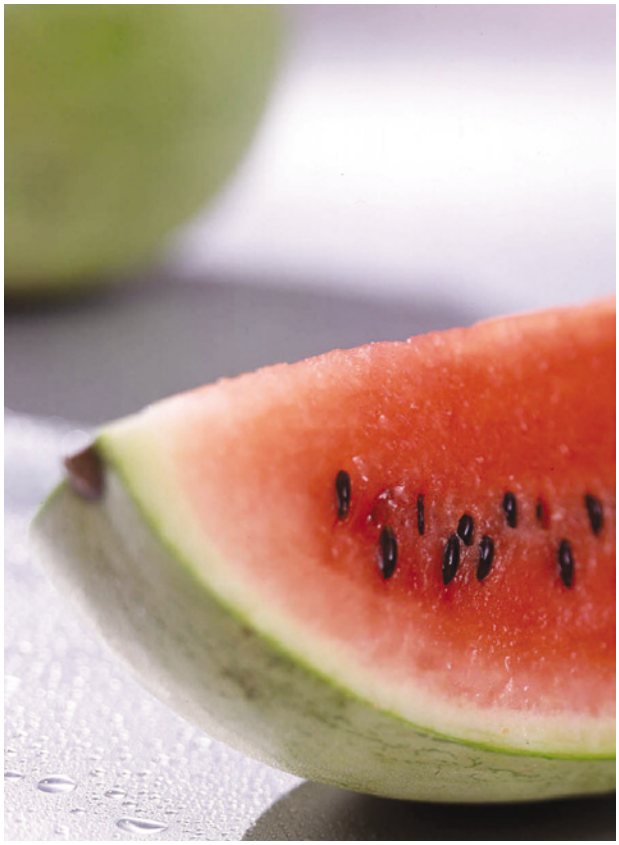
Examination of the Cucumber

Taking a closer look at the cucumber, F-1 is a simplified representation of the lipoxygenase enzyme system that generates C9 flavor volatiles — considered to be key to the cucumber flavor.

In an ideal world, the cucumber would stop at Point A (F-1) — when the maximum level of *trans*-2-nonenal and *trans*-2-, *cis*-6-nonadienal has been generated. However, with enough time the alcohol dehydrogenase (ADH) and various isomerase enzymes are able to convert these into the far less typical range of alcohols present at Point B (F-1).

To prevent this, it may be possible to add processing aids that inhibit the enzymatic conversion of the aldehydes into alcohols. Alternatively, the cucumbers may be genetically modified to have the ADH enzyme switched off. Although these scenarios could prove successful, they would not appeal to FTNF flavor ingredients manufacturers trying to maintain a truly natural approach. Here manufacturers must accept what nature has provided and work within its limitations.

Specialist manufacturers have a rule that cucumbers should be puréed no more than 30 min prior to processing. Flavor



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Watermelon (Citrullus lanatus) originated in Africa about 5,000-6,000 years ago.

removal — in the form of a low-temperature, high-vacuum distillation — should be completed in seconds, not minutes or even hours. An FTNF cucumber product that is low in *trans*-2-, *cis*-6-nonadienal and high in the equivalent alcohol is an indication that the purée was allowed to stand for extended periods. It could also signify that distillation was too slow, or that the solvent extraction process required several minutes or hours to remove volatiles from the cucumber purée.

Summary

The recent shift in demand from synthetic to all-natural products has put increased pressure on the flavor industry to produce authentic natural products that resemble the actual fruit. Today's consumers continue to encourage manufacturers to create tasty, innovative products developed through entirely natural processes. Moreover, the actual processing conditions play a crucial role in natural product development. Flavor ingredients manufacturers, using high-grade raw materials and adhering to rigorous storage regulations, have the key to delivering premium quality products. ■

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A simplified representation of the lipoxygenase enzyme system that generates C9 flavor volatiles **F-1**