CEVICHE

How acid “cooks” seafood without heat

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What's ceviche?

Ceviche is raw seafood marinated in an acidic fruit juice. Served throughout Latin America, it's particularly popular in Peru, Mexico and Ecuador. The seafood used is usually white-flesh fish such as sole, grouper, flounder, halibut or red snapper, although shellfish like shrimp and scallops also make great ceviche. The acidic fruit juice can vary from lime juice (the most common) to lemon juice to passionfruit juice to Seville (bitter) orange juice. Though the flavor and ingredient variations are endless, the net effect is the same: The acid in the juice firms up the raw fish and turns it from translucent to opaque, making it appear as if the fish has been cooked.

“Cooking” without heat

Seafood is built from proteins, and citrus juice is acidic. Acid alters the structure of proteins the same way that heat does. A protein molecule maintains its shape due to a balance of electrical forces that push and pull on its molecular structure. Acid knocks these forces out of balance. Like all acids, citrus juices have a net positive charge that causes protein molecules to change their shape or “denature”.

You can watch this happen when you squeeze citrus juice on raw fish. The translucent flesh gradually turns opaque and starts to firm up. Over time, the texture changes from wobbly to compact, in much the same way that heat transforms fish from raw to cooked. The main difference is that heat accomplishes these changes in minutes, whereas acid can take anywhere from hours to days, depending on its strength.

Many shades of ceviche

Chile peppers are often included in ceviche, and the dish may also include salt, soy sauce, and/or various aromatics ranging from alliums, such as red onions, shallots, garlic, and/or scallions, to fresh herbs like cilantro and mint. In Peru, the leftover marinade is sometimes mixed with pisco (Peruvian brandy) to make a cocktail called leche de tigre (tiger's milk), which is considered a hangover cure and aphrodisiac. The term “Tiger's milk” may also refer to a flavor-enhancing broth made from fish stock that's added to ceviche to balance the acidity of the marinade and to deepen the savory umami flavor. As a shortcut to umami flavor, instead of tiger's milk, aji-no-moto (monosodium glutamate) is often added to Peruvian ceviches.

Peruvian food is heavily influenced by Japanese Nikkei cuisine, and in Peru, some ceviches are closer to sashimi. Called tiraditos, they emphasize the pure flavor of the raw fish with shorter marinating times and fewer accompaniments.

Ceviche may also be made with cooked fish. And some versions include sweet fruit and other surprising ingredients, such as evaporated milk in the marinade for a creamy texture.

Different juices, different strengths

The stronger the positive charge of an acid, the more dramatically and swiftly it shows its effects. Acidic strength is measured in terms of pH. The lower the pH number, the more acidic the ingredient. Lemon and lime juices, the most common acids in ceviche, have a pH between 2.0 and 2.6. Lime juice tops out at 2.35 pH, making it the stronger of the two, on par with commercial vinegar. Other acidic juices, like orange, pineapple or passionfruit, which are often added to ceviche for flavor, have a pH between 3 and 4, so they react more slowly with proteins.

Is ceviche safe to eat?

Ceviche is made from raw fish, so it's important to use only the freshest seafood. Bacteria always exist on fish, and the longer the fish is stored, the more opportunity that bacteria has to multiply. The acid of fruit juice won't kill as many pathogens as heating raw fish to at least 145 degrees. However, the most common bacteria found in fish (Listeria, Clostridium perfringens, Salmonelia, and V. cholerae) can survive acidity less than 4.5 Ph, so they're

effectively destroyed by prolonged exposure to citrus juice. Parasites are another matter though; most can survive acidic environments. The few fish parasites that are harmful to humans can be eliminated by flash-freezing, which isn't possible to do in a home freezer.

Acid's Assets

Raw seafood tastes briny like the sea with various savory and sweet flavors depending on the species. It also bears the faint metallic bitterness of trace minerals like magnesium, potassium and calcium from sea water. When you marinate raw seafood, it picks up additional flavors from the marinade. In ceviche, the dominant flavor is sour from the citrus juice. The particular pH from the juice used in the marinade determines how sour the ceviche tastes.

The acid also helps the fish to pick up the flavors of other ingredients in the marinade, from chiles to garlic to herbs. As acid unravels the chemical bonds between proteins in seafood, it also encourages the proteins to bond with other flavor compounds.

Acid has another particularly useful effect on seafood. It lessens the briny smell that some find unpleasant. That's one reason why seafood is often accompanied by a squeeze of lemon. One of those fishy aromas is trimethylamine (TMA), a foul-smelling compound released as enzymes and bacteria attack fish after it is killed. Rinsing fish can remove surface TMA but acid goes a step further, causing TMA to bind with water and become less volatile, so you're less likely to inhale and detect the odor. Acid also neutralizes the source of another stinky fish odor: pungent-smelling aldehydes. And it helps break down two muddy-smelling compounds (geosmin and methylisoborneol) that you might have noticed in farm-raised fish and bottom feeders, such as catfish, that feed on algae.

Betyween TMA, aldehydes, geosmin and methylisoborneol, the acid in ceviche is truly a magic ingredient; it just makes fish taste and smell better. Acid also helps to balance the complete flavor profile of a dish. If a ceviche is made with oily fish like tuna or mackeral, or if it includes a sweet fruit like mango, the acid cuts through the fattiness of the fish and mutes the sweetness of the fruit, helping to create a balance of flavors.

The role of salt

A little salt in ceviche enhances the flavors and aromas of whatever is in the marinade and improves the flavor of the fish itself. The use of salt per se isn't critical to ceviche – sometimes the marinade is seasoned with soy sauce or a broth made with briny seaweed – but whatever the vehicle, it makes proteins more soluble in low concentrations. Dissolved protein in a marinade makes the liquid look cloudy.

In higher concentrations, sodium also draws moisture from the fish, the same way that acids do, causing it to gradually dehydrate. That water loss is why fish shrinks slightly in ceviche while the amount of liquid in the marinade increases. On the upside, this dehydrating effect helps fish taste fresh longer by inhibiting harmful bacteria growth, much the same way that salt dehydrates and “cures” meat.

Salt also heightens the flavors of aromatic chiles, herbs, onions and other seasonings in the marinade. And it helps to suppress bitter flavors.

FRUIT JUICE pH

The lower the pH, the higher the acidity

Lime	2.0-2.35	Key lime	2.6-3.0	Tangerine	3.7-3.8
Lemon	2.0-2.6	Grapefruit	2.9-3.2	Apple	3.7-3.9
Cranberry	2.3-2.6	Pomegranate	2.9-3.2	Blood orange	3.7-4.5
Wine or cider vinegar	2.4-3.4	Passionfruit	3.0-4.8	Tomato	4.01-4.6
Meyer lemon	2.5-2.7	Pineapple	3.3-3.6	Guava	5.2-5.6
Seville (bitter) orange	2.6-2.9	GrapeJuice	3.3-3.7	Papaya	5.2-5.7
Yuzu	2.6-2.9	Valencia (sweet) orange	3.69-4.34	Mango	5.8-6.0