Flavoring Protein Foods & Beverages

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2021 PREMIUM WEBINAR:

OVERCOMING TECHNICAL ISSUES WHEN FORMULATING WITH PROTEIN

A Global Food Forums, Inc. Event

Long term problem but more pressing due to consumer trends

1. More protein in diet – all sources
2. Plant proteins – unique proteins
   - Sustainability
   - Environmental issues

Proteins

1. All bring unwanted inherent off notes (Ideally white in color and bland in flavor)

2. Many challenges in flavoring them
   - Flavoring initially
   - Loss during thermal processing and storage (product shelf-life)
     - * Note: we seldom know the cause of end of shelf-life
     - Is it being overwhelmed by off flavors (e.g. oxidation?) or
     - We no longer have a strong desirable flavor? (combination?)

How do we manage without knowing mode of failure?

We add antioxidants

We encapsulate

We use expensive gas packaging

Should we?????

Some orgs think so ……..

Midwest Dairy Association (https://www.midwestdairy.com/) – given me a 2 year grant to learn how to create and protect flavor when using dairy protein ingredients.

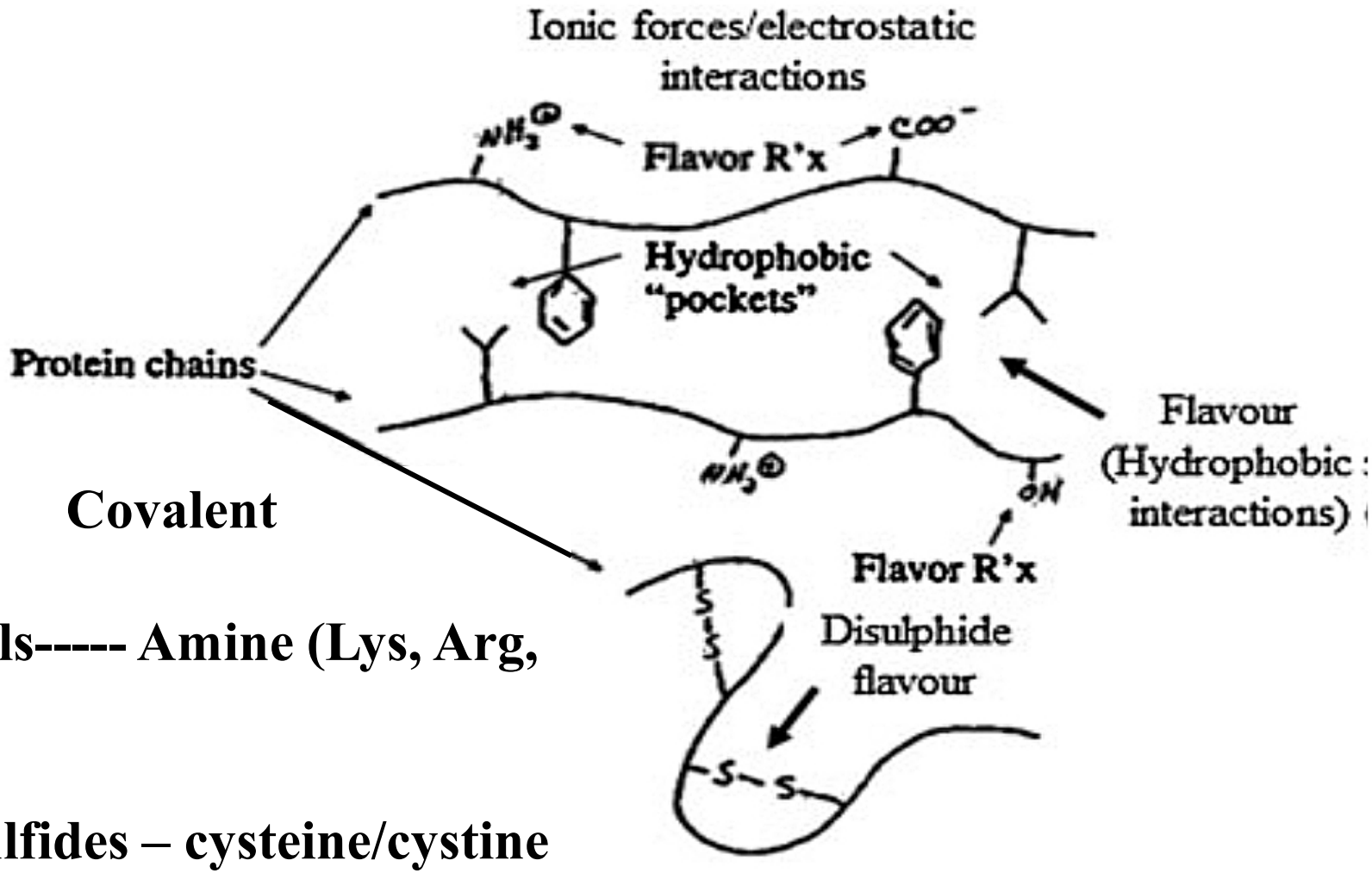
Plant Protein Innovation Center (https://ppic.cfans.umn.edu/) – 1 year grant to learn how to create and protect flavor when using novel plant protein ingredients.

What have we learned from past research and now present?

Flavor: Protein interactions

1. Weak Bonds – e.g. ionic, hydrophobic, hydrophilic

2. Strong bonds - covalent



Covalent

Carbonyls----- Amine (Lys, Arg, His)

Thiols/sulfides – cysteine/cystine

Challenges

Weak bonds - Problematic but come to an equilibrium and through flavor reformulation one can manage.

Covalent bonds - Occurs rapidly when heat treating – pasteurization, sterilization

Slowly over shelf-life (end of shelf-life – flavor loss or off flavor buildup)

Do not come to equilibrium! – consume AA or flavor

Past efforts – Weak binding

First efforts in mid 1960's– to present

Have researched for nearly 60 years and what is the benefit?

I.e. how has this research helped us make foods taste better/longer?

Learnings

Binding depends upon the flavor compound (but expect all compounds to exhibit some bonding)

- Hydrophobicity
- Functional group
- Location of functional group in molecule

Flavor compound	Binding constant K_B [M^{-1}]
β-Ionone	19,143
α-Ionone	13,456
Γ-Undecalactone	9,924
β-Damascenone	6,073
2-Nonenal	4433
2-Nonanone	3230
Γ-Decalactone	2055
1-Nonene-3-ol	2055
2-Octenal	1579
2-Octanone	1287
Me Benzoate	1005
1-Octen-3-ol	699
2-Heptenal	576
2-Heptanone	465
γ-Octalactone	450
Benzaldehyde	341
1-Hepten-3-ol	250
Γ-Octalactone	231
2-Hexenal	218
2-Hexenone	163
2-Pentenal	61
Pentanone	42

Learnings

Proteins differ in affinity for flavor components – same flavor different protein – different flavor character (Do not have data to know what is the least problematic protein – we should!)

Bottom line?

Challenges getting the right balance due to weak bonding but possible

Strong (covalent) bonding

Only recently able to study – development of research techniques

Find aldehydes (especially unsat. ald.) and some sulfur compounds to be very reactive – flavor changes rapidly during heat treatment and progresses during shelf-life.

- Measureable reactions in minutes
- Very specific in reaction – much more so than weak bonding
- Flavor is lost (5% casein solution will consume 70% of citral flavoring)
- Product may become turbid (protein cross linking by flavor molecules)

Flavor reactions?

Practical research applied to industry problem

We need fundamental understanding of what:

- Reactions occur (key flavor compounds)
- How protein AA profile and protein conformation influence reaction rates (protein)
- How reaction environment (pH, aw, temp, ?) influence reaction rates (food)

Practical research applied to industry problem

- What proteins are most unreactive – protect the flavor molecules that are important to product.

- Protein treatment affect reactions?
  - Denaturation
  - Hydrolysis (how much has an effect?)
  - Protein protection - Blocking by Glycation?

Flavor industry challenge

Design a flavor for a protein in a specific application that works as long as desired

Creativity! New unreactive flavorings tailor-made for

a specific protein/application

USDA proposal this year to accomplish the goals I have presented

Failed last year – not accustomed to write government grants – always worked with the industry

If you agree that this research would help and food/flavor industry, please contact me at greinecc@umn.edu

An industry letter of support is helpful

Q & A

QUESTION: What are some tactics that could be taken to mitigate protein taste issues in a formula?

ANSWER: The industry has found ways to manage the off flavors that accompany most protein sources. If the protein carries a very mild or less noticeable off notes, one might just put a flavoring that is more intense or defined. When the protein is caring more pronounced undesirable flavor, the flavor company can design/compound a flavor that's more in line with the characteristic inherent flavor. The company would just reduce in their formula notes that would be provided by the protein source. It's a fairly successful approach but does limit one's choice of flavorings.

Q & A

QUESTION: How do we increase protein concentration without the plant protein off flavor?

ANSWER: The off notes that you are referring to are inherent in the protein that you're using. If you use more protein, you are going to bring in more off flavor.

QUESTION: What makes protein off flavored?

ANSWER: Protein does not have any flavor at all – taste or smell. However, the protein is very good at binding volatile compounds, that is, flavor compounds. Any plant metabolites that make peas, for example, taste like peas will get trapped in the protein and follow the protein throughout the isolation process. If these flavors are so strongly bound to the protein, you might ask why then are we able to smell them? Shouldn't they be bound and not have an odor? The answer is that anything we do to that proteins such as heat, change pH or denature in some manner, also changes the binding and to some extent releases the flavor compounds to be sensed.

Q & A

QUESTION: How does flavour interact with different kinds of protein such as with soy or pea protein?

ANSWER: Research has shown the different proteins bind different flavors with different strengths. Unfortunately, there has not been enough research done comparing proteins to one another to be able to give you a recommendation as to the best protein to work with.

QUESTION: Are there ways we can remove unpleasant flavors of plant proteins without adding other flavors from different sources to it?

ANSWER: You have brought up the question of whether the undesirable flavors inherent to a protein can be removed through various processing steps. We have been studying that and have found that the typical steps involved in isolating a protein do not result in the removal of objectionable flavors. The objectionable flavors get bound to the protein and travel with it throughout processing. We are going to have to insert a processing step that releases and extracts these objectionable flavors.

Q & A

QUESTION: Why does flavour fades away during storage?

ANSWER: In my presentation, I discussed the two different types of binding that occur between proteins and flavor compounds. One type of binding is very weak and comes to an equilibrium — that is, it is stable over time. I also spoke of covalent bonding. That bonding takes place very slowly during storage but gradually will consume all your flavor. I mentioned that if your flavor fails during shelf life, you cannot be sure that the flavor became objectionable to the consumer because of the chemical bonding of that desirable flavor to your protein or if the food had been degraded by oxidation or due to some other spoilage mechanism. We should have an answer to that one and we do not.

QUESTION: What are some flavors that are more stable that are currently on the markets?

ANSWER: Some of the fruit flavors are quite stable. For example, Concorde grape is exceedingly stable, apple, peach, banana, and other grapes are fairly stable. Some such as cherry, lemon, coffee and almond are terribly unstable.