

# Emerging Protein Ingredient Technologies for Strategic Business Development

NOTE: Slightly edited from original version presented at the conference.

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David Lafond Ph.D., MBA



Lafond Food Technology LLC

# Disclaimer

- I am a food scientist with about 40 years of R&D experience
- Worked for Kraft, Quaker Oats, Keebler and Kellogg before starting up my consulting company
- Over the last decade I have looked for new food technologies and worked with a wide variety of functional plant ingredients
- I am currently working with clients to find new ingredient technologies they can use in their innovation programs
- In keeping with conference policy, vendor companies or branded ingredients will not be mentioned



# My mission within my company

- Is to help clients identify a pipeline of technologies to produce ingredients, protein, fiber, etc. to sustain the high value portion of the revenue curve
- I attend most of the large global food conferences to determine trends, and look for new suppliers or new research in specific categories
- I also attend smaller conferences where startups pitch their companies achievements and funding needs
- I have met with companies all over the world and have learned to recognize what is truly new and what its potential can be



# Outline

- Protein demand
  - Market trends
  - US consumer concerns
  - Plant vs. animal
  - Positive for the environment
  - Avoidance of issues
  - Protein ingredients lifecycle from specialty to commodity
- Emerging plant sources of protein
  - Grains, pulses, and oilseed based
  - Grain white space - oat, buckwheat
  - Pulses - mung bean
  - Oilseed - canola
- Technology used to provide new plant proteins
  - Fermentation
    - Algae
  - Synthetic Biology
    - Yeast
    - Cell cultures
  - AI and Big Data





# Macro Technology Trends

- Healthy Ingredients
  - Ingredients without health negatives (low sugar or low sodium)
  - Ingredients with an added health benefit (fiber that reduces appetite)
  - Taste, convenience, and price saw a decline as drivers over the last 5 years with 60% of gain coming from healthy<sup>1</sup>
  - Weight loss/maintenance is most desired health benefit with 1 in 3 under age 50 interested in weight loss<sup>1</sup>
- Recognizable Ingredients
  - Uncomplicated easy to understand ingredients and where they come from
  - 30% of food shoppers would buy more food products if they contain easily recognizable ingredients<sup>3</sup>
- Clean Label
  - Simple easy to understand ingredients, common, short list
  - More than one third of US consumers now buying organic<sup>2</sup>

<sup>1</sup> IFIC (International Food Information Council)

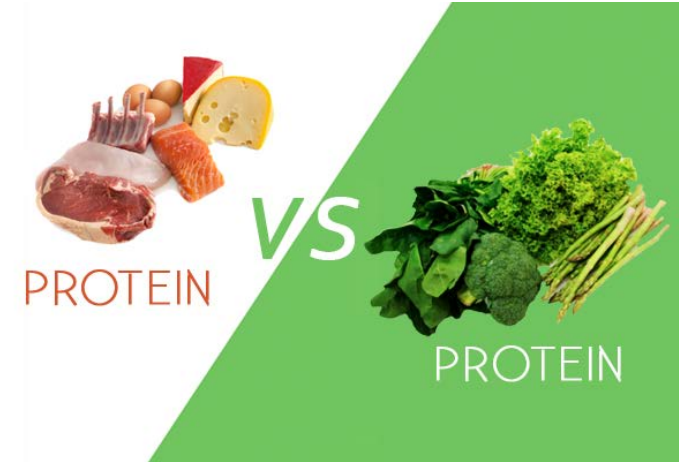
<sup>2</sup> Packaged Facts' 2016 Natural and Organic Foods U.S. report

<sup>3</sup> Mintel



# Consumers seeking alternatives

- Consumers eat more than the recommended amount of protein, the majority from animal based sources (fresh meat and dairy)
- Current protein market is dominated by very few sources; whey, soy, beef
- Plant protein market is extending beyond soy to include lupine (pea), and other proteins from insect, and algal ingredients
- Key markets including Australia, China, and France, are making legislative changes to curb meat consumption and divert consumer to plant based diets



# The market for plant based proteins is growing



- 1/3 of protein consumption is anticipated to be plant based by 2054
- New products with plant based protein grew 14.7% in 2014 while animal protein grew only 7.5%
- 26% of consumers said they ate less animal protein in the last 12 months
- 60% of millennials consume plant based meat analogs



# US Consumer Concerns

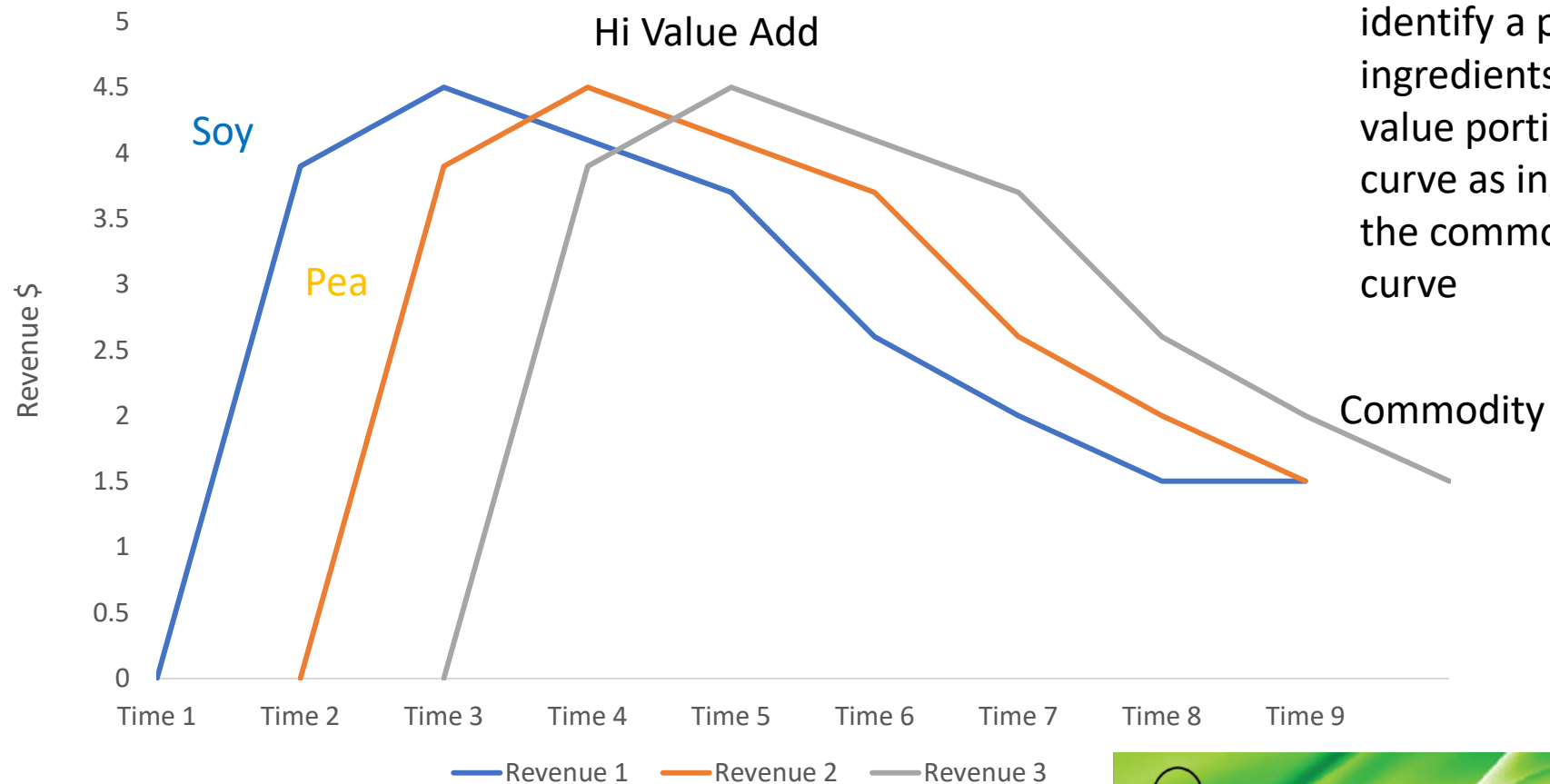
- Consumers don't trust big food companies or the claims they make
- Many consumers are choosing vegan as a dietary practice and vegan products are becoming more mainstream
- Animal and dairy sources of protein bring concerns of:
  - Growth hormones and clean label
  - Sustainability - land use, carbon footprint, circular economy
  - Allergens
  - Animal rights





Plant proteins move from high value to commodity as more suppliers enter the space

## Plant Protein Revenue Curve



Protein suppliers need to identify a pipeline of ingredients to sustain the hi value portion of the revenue curve as ingredients move to the commodity region of the curve



# Emerging plant protein roadmap

Grains		Pulses		Oilseeds		Other	
Quinoa		Chickpea		Flax		Algae	
Amaranth		Lentils		Canola		Potato	
Teff		Mung Bean		Hemp		Insect	
Rice				Pumpkin Seed		Nettles	
Oat							
Buckwheat							

Plant sources are dependent on the protein content and the agronomics – cost of growing, harvesting, and extraction



# Building the consumer connection

- Protein content and plant source is common messaging to consumers
- Protein content or quality may not be enough of a key message to consumers

What else can you say?

- Processing technology is getting cleaner, many suppliers are providing proteins with less chemicals or solvents used
- Nutritional benefits; based on clinical evidence
- Plant proteins like those from ancient grains provide a history to talk about



# Potential new plant proteins

- Grains
  - Ancient grains - proteins that provide a story
  - Grain white space - oat, buckwheat protein
- Pulses
  - Growing interest in pulses
  - Pulse white space - mung bean protein
- Oilseeds
  - Typically oil is the desired fraction; changing as plant protein interest grows
  - Oilseed white space - canola and hemp protein
- Other
  - Algae protein- origins story
  - Nettles protein- can provide a story
- Need to find a story for these plant proteins





# Consumers want more information

- Consumers are wanting to know where products and ingredients come from
- Knowing the farmer that grows the plants that is made into an ingredient that goes in food is important from a traceability standpoint, and begins to build a relationship with the consumer
- This may be one story you can tell and technology can help you do it



# Using technology to build the consumer relationship and tell the story

- One degree of separation from the farm to your table



<https://www.youtube.com/watch?v=b4KyQOcGWBI>



# Ethnobotany may provide a story

- CN Plants used in Chinese medicine
  - IN Plants used in Ayurvedic medicine
- Libraries of ingredients used over thousands of years validated by trial and error
- Science is only now building the supportive research on these ingredients
  - If you are trying to sell in this market it might be more relevant to use plants with a local history
  - us/CA Native American plants - not as well documented and at an early stage of supportive research



# Submitted for publication



ETHNOBIOLOGY LETTERS

Research Communication

## **Nutritional Properties of Native Plants and Traditional Foods from the Central U.S.**

Kelly Kindscher<sup>1\*</sup>, and Leanne Martin<sup>1</sup>, and Steve Corbett<sup>2</sup>, and David Lafond<sup>3</sup>

<sup>1</sup>Kansas Biological Survey, 2101 Constant Ave., University of Kansas, Lawrence, KS 66047

<sup>2</sup>Kansas Health Institute

<sup>3</sup>Lafond Food Technology LLC



Lafond Food Technology LLC



# Vegetables - Nettles



Nettles (*Urtica dioica*) leaves and young shoots.

The leaves of nettles (*Urtica dioica*), had the highest protein value, have numerous uses as food and medicine in both the Eurasia and North America (Moerman 2013; who lists 222 uses).

It was used extensively across America as food by the Iroquois and Mohegans in the Northeast, the Skagit, Makah, Hoh in the Northwest, and Alaskan Natives (Moerman 2013).

They have a unique taste that is rich and pleasant.



# Fermentation used to provide new plant proteins

- Basically a biological process involving breakdown of nutrients by bacteria, yeast or other organisms like algae to produce desired end products
- Consumers believe it to be safe and familiar (beer, sourdough, sauerkraut)
- An old process being revisited to produce protein from micro organisms





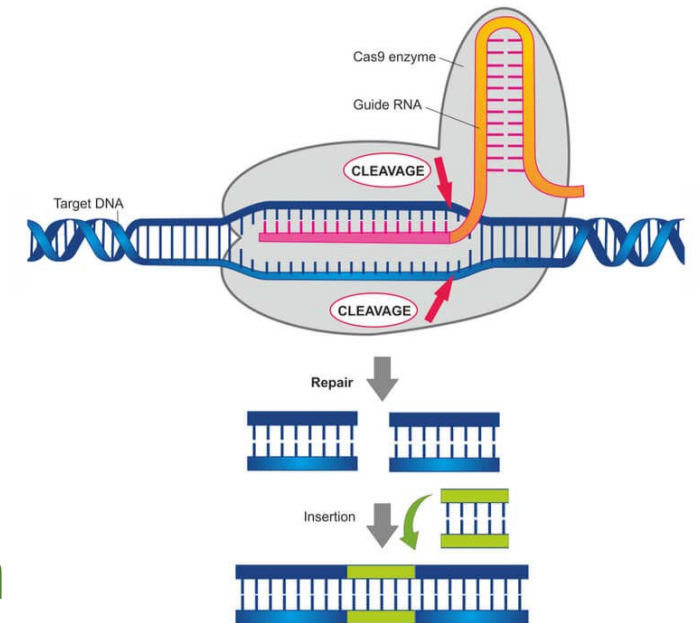
# Fermentation by Algae

- Algae protein production - fermentation used to grow microalgae with a high protein content and balanced amino acid profile
  - Different species require different processes
  - Some use artificial light to stimulate algae to grow
  - Some use fermentation tanks with a carbohydrate source
  - Some use outside tanks or ponds to grow algae in somewhat controlled conditions
  - Manipulation of the growing conditions can optimize the protein production
- Can tell a story about algae



# Synthetic biology used to provide new proteins through fermentation

- CRISPR-cas9 is a breakthrough in genetic modification techniques
- It acts like cut and paste in a word processor
- It allows for precise insertion of specific genes into genome
- By utilizing CRISPR-cas9 you can insert genes into yeast to make proteins
- Then the yeast is propagated by fermentation and the new proteins are generated by the yeast and extracted





# Protein production thru fermentation

- By inserting the right genes in yeast it can be used to produce virtually any protein
- Modifying yeast is being done by specialty companies to produce desired proteins
- Yeast is being used to produce animal proteins
- Proteins are produced sustainably, efficiently, without environmental variations seen in agriculture
- Modified yeast can be removed from proteins so they not present in food ingredient thus not GMO



# Business applications

- Animal Proteins from plants
  - Clean meat alternatives
    - 95% < land, 74% <water and 87% <greenhouse gas
    - Use yeast to make heme and combine with soy, texturized wheat protein and potato protein
  - Milk without cows
    - Modified yeast to produce 5 key milk proteins
  - Eggs without chickens
    - VC that makes an egg white protein without chickens



# Cell Cultures

- Another technique to making unique protein based products is to take cells from the desired animal and grow them in cell cultures
- Enables you to grow the cells in a highly controlled environment

## Business application

- Fish without fish
  - Targeting high priced fish products, no heavy metals, prevent bluefin tuna extinction
  - Making pastes now of individual cells; working on higher order structure



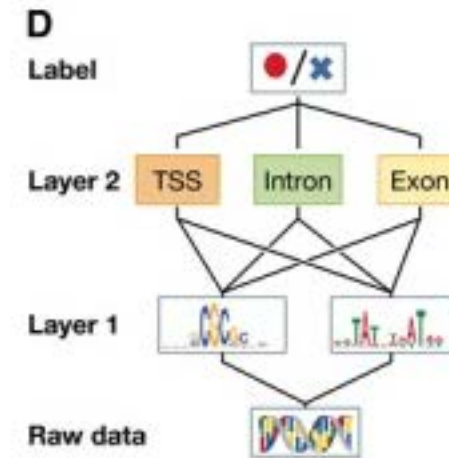
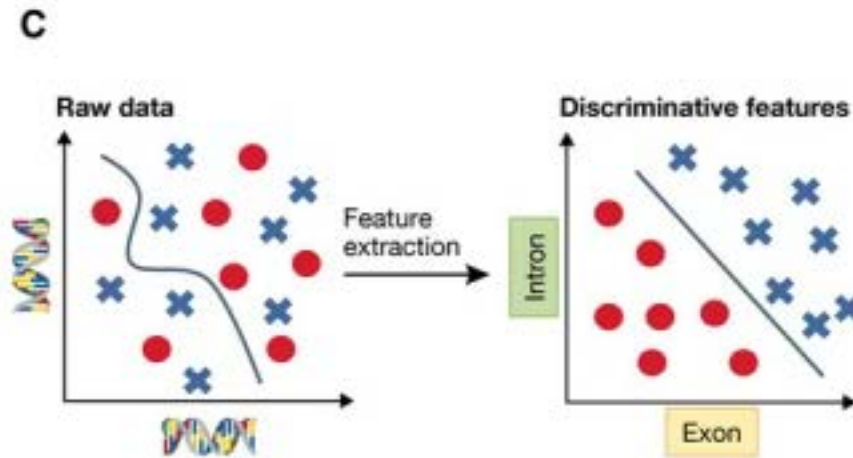
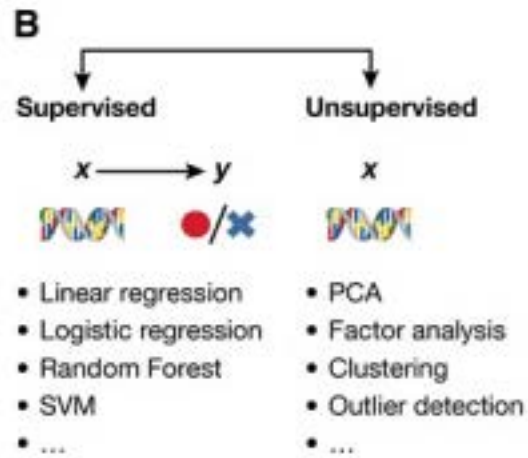
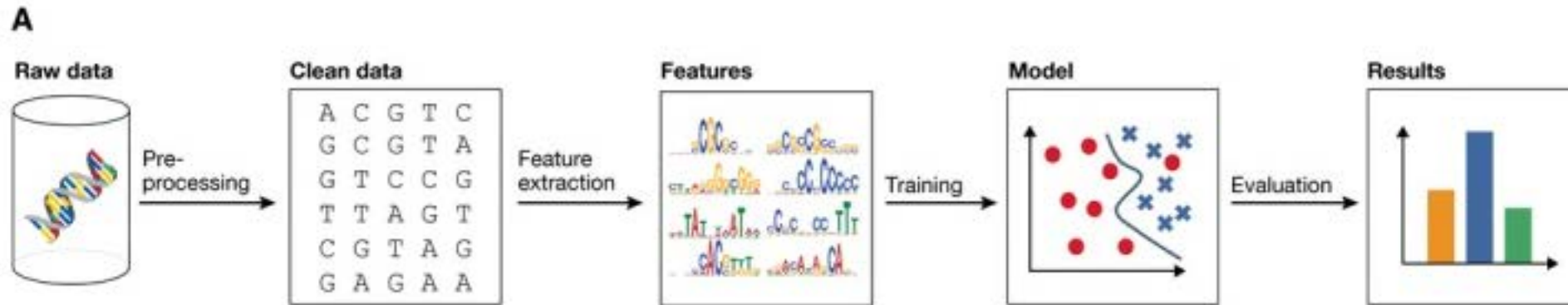
# AI and big data is used to provide guidance on which plant proteins to target

- Use computational biology and machine learning to screen plants
- Proteins extracted from plants and their molecular and functional characteristics are evaluated
- Data is collected on wide variety of parameters
- Resulting in a massive database of information and with specific search algorithms, predict proteins with specific functional properties





# How computational biology works



# Business Applications

Startup company in SF used this technique

- Built an extensive database of plants and properties
- Set up proprietary algorithms to screen the data and identify functional properties
- Market a number of protein products one of which is an egg substitute from mung bean protein
- Found mung bean protein thru their AI program



# Conclusions

- Content claims on proteins can be made more attractive to consumers by telling a story about where they come from and using ingredients that have a history associated with them
- Communicating the history can provide the first steps to building a stronger relationship with consumers
- Fermentation can provide a rich source of proteins from plants that is cost effective and without the issues with animal sources
- New techniques in gene editing can enable yeast to produce the desired protein
- New techniques in computational biology can help predict which plant proteins to target for specific uses



# Thank You

You can reach me at:

Lafond Food Technology LLC

[Lafond.dave@gmail.com](mailto:Lafond.dave@gmail.com)

(269) 203-5449

