DIY FERMENTATION: MAKING FOOD BASED PROBIOTICS AT HOME

SUSAN AARONSON, RD
JILL SCHNEIDERHAN, MD

CREATING A SPACE FOR HEALTH: INTEGRATIVE HEALTH IN PRIMARY CARE

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OBJECTIVES

• PARTICIPANTS WILL BE ABLE TO DESCRIBE THE BENEFITS OF FOOD BASED PROBIOTICS

• PARTICIPANTS WILL BE ABLE TO DISCUSS THE KEY ELEMENTS FOR SAFELY FERMENTING FOOD AT HOME

• PARTICIPANTS WILL BE ABLE TO DEMONSTRATE HOW TO MAKE A FERMENTED VEGETABLE PRODUCT
THE MICROBIOME

• THE MICROBIOME CONSISTS OF ALL THE MICROBES THAT LIVE ON AND IN HUMANS
• CONTRIBUTES 99% OF THE GENETIC MATERIAL IN THE HUMAN BODY
• THE HIGHEST NUMBER OF ORGANISMS ARE FOUND INSIDE THE GASTROINTESTINAL TRACT
• MOST ARE BACTERIA
• 90% AREANAEROBIC
SOME BASIC TERMINOLOGY

- **Prebiotics** - Nondigestible complex sugars that promote growth and metabolic activity of beneficial colonic bacteria.
  - Most common prebiotics found in supplements are fructo-oligosaccharides (FOS’s). I.e. inulin and oligofructose.
  - **Fermentable fiber**, di-, poly-, oligosaccharides (found in bran, psyllium, quinoa, buckwheat, raw oats, rye, honey, legumes, beer, onions, garlic, burdock root, chicory, legumes, asparagus, rye, Jerusalem artichokes, bananas, berries, nuts, leafy greens).
SOME BASIC TERMINOLOGY

- **PROBIOTICS** - LIVE MICROORGANISMS, INCLUDING BACTERIA AND YEAST, WITH BENEFICIAL PROPERTIES FOR THE HOST
  - Measured in Colony Forming Units (CFUs)
  - Naturally occurring in fermented foods

- **SYNBIOTICS** - COMBINATION OF PROBIOTICS AND PREBIOTICS
GUT FLORA

• THE COMPOSITION OF THE GUT FLORA IS DIVERSE
• EACH INDIVIDUAL HAS A UNIQUE MICROBIAL FOOTPRINT
• SMALL NUMBER OF GENES RESPONSIBLE FOR THE MAJOR FUNCTIONS OF THE GUT FLORA

• FACTORS THAT CONTRIBUTE TO THE COMPOSITION INCLUDE:
  • HOW A PERSON IS BORN (CESAREAN SECTION VS. VAGINAL),
  • BREAST OR BOTTLE
  • USE OF ANTIBIOTICS
  • DIET (SOLUBLE FIBER FROM FRUITS AND VEGETABLES IS PARTICULARLY IMPORTANT)
  • HYGIENE/SANITATION.

PROBIOTICS AND NORMAL FLORA

• ROLE IN DIGESTION/NUTRITION
  • SUPPLYING ESSENTIAL NUTRIENTS THROUGH THEIR BREAKDOWN OF COMPLEX CARBOHYDRATES
  • GENERATING SECONDARY BILE ACIDS THAT ASSIST IN THE DIGESTION OF FATS
  • SYNTHESIZING VITAMINS SUCH AS VITAMINS K, B12, FOLATE, AND BIOTIN

• ROLE IN IMMUNE SYSTEM/PROTECTION
  • CONTRIBUTE TO THE DEFENSIVE BARRIER IN THE COLON
    • STIMULATE MUCOUS PRODUCTION, LYMPHATIC TISSUE DEVELOPMENT, ANTIBODY FORMATION
    • INDUCE PROTECTIVE CYTOKINES, SUPPRESS PRO-INFLAMMATORY CYTOKINES IN THE MUCOSA OF PATIENTS THROUGH THE ACTIONS OF SHORT CHAIN FATTY ACIDS (SCFA'S)
  • INTERACT WITH OUR SYSTEMIC IMMUNE SYSTEM IN A WAY THAT MAINTAINS A LEVEL OF HOMEOSTASIS
    • ALLOWING FOR THE APPROPRIATE ACTIVATION
    • WITH NO AUTOIMMUNITY

PROBIOTICS AND NORMAL FLORA

• ROLE IN GUT-BRAIN AXIS
  • BIDIRECTIONAL COMMUNICATION
    • BRAIN CAN SIGNAL ENTERIC NERVOUS SYSTEM TO SPEED UP OR SLOW DOWN TRANSIT TIME
    • NEUROTRANSMITTERS GENERATED BY GUT BACTERIA CAN AFFECT PATHWAYS IN THE CNS
  • HORMONAL SIGNALING
  • NERVOUS SYSTEM COMMUNICATION\textsuperscript{1,2}

• MODULATE PAIN PERCEPTION
  • L ACIDOPHILUS INDUCES EXPRESSION OF MU-OPIOID AND CANNABINOID RECEPTORS IN INTESTINAL EPITHELIAL CELLS, MEDIATES ANALGESIC FUNCTIONS SIMILAR TO MORPHINE\textsuperscript{3}

HEALTHY MICROBIOME

- INCREASED MICROBIAL DIVERSITY
  - DISEASE MARKERS RISE WITH DECREASED DIVERSITY
  - INCREASED ADIPOSITY, INSULIN, TRIGLYCERIDES AND C-REACTIVE PROTEIN. ¹

- SPECIFIC SPECIES ASSOCIATIONS
  - A NUMBER OF STUDIES HAVE FOUND ASSOCIATIONS WITH PARTICULAR BACTERIAL SPECIES AND DISEASE MANIFESTATION.

- CHANGING DIET ALONE CAN HAVE A SIGNIFICANT IMPACT
  - NUMBER OF SPECIES PRESENT

- INCREASES IN SOLUBLE FIBER THROUGH INCREASED SERVINGS OF FRUITS AND VEGETABLES LEADS TO THE GREATEST LONG TERM IMPROVEMENT IN THE MICROBIAL DIVERSITY. ²

NATIVE GUT FLORA

• STOMACH
  • LACTOBACILLUS

• PROXIMAL SMALL INTESTINE
  • RELATIVELY FEW BACTERIA (~10^5 - 10^7 PER ML FLUID): PRIMARILY LACTOBACILLUS, ENTEROCOCCUS

• TERMINAL ILEUM
  • TRANSITIONAL ZONE, BOTH AEROBIC AND ANAEROBIC ORGANISMS (~10^8/ML): LACTOBACILLUS, BACTEROIDES, ENTEROCOCCUS, E. COLI

• COLON
  • PRIMARILY STRICT ANAEROBES (~10^{11}/ML): BACTEROIDES, BIFIDOBACTERIA, ENTEROCOCCUS, E. COLI, LACTOBACILLUS, CLOSTRIDIUM, STAPHYLOCOCCUS, KLEBSIELLA, ENTEROBACTER
ABOUT THE EVIDENCE

• HETEROGENEOUS EVIDENCE BASE
  • MAKES ACCUMULATING EVIDENCE FOR ANY ONE PROBIOTIC DIFFICULT
  • META-ANALYSIS ARE CHALLENGING

• LOTS OF SMALL STUDIES
  • SOME USING PROBIOTIC SUPPLEMENTS
  • SOME USING FERMENTED FOODS

• NO ONE YET LOOKING AT GUT FLORA MAKE UP OF THOSE PARTICIPATING IN STUDIES
  • LIKELY WILL NEVER BE A ONE SIZE FITS ALL TREATMENT
IRRITABLE BOWEL SYNDROME

• PROBIOTICS ASSOCIATED WITH DECREASED PAIN, BLOATING, URGENCY ¹,²

• RESTORE MORE NORMAL GUT MICROFLORA, IMPROVE INTESTINAL PERMEABILITY, NORMALIZE IMBALANCES IN INFLAMMATORY CYTOKINE RATIOS

• SOLUBLE FIBER, COMMONLY FOUND TO BE HELPFUL IN TREATING IBS, HAS BEEN SHOWN TO HAVE PROFOUND EFFECTS ON IMPROVING MICROBIOTA DIVERSITY AND IN SHIFTING THE COMPOSITION TOWARD LESS PATHOGENIC STRAINS ³,⁴

• DOSING:
  • VSL#3, 225 BILLION CFU DAILY-BID
  • MULTIPLE STRAINS OF BIFIDOBACTERIUM AND LACTOBACILLUS, 20-40 BILLION CFU, DAILY TO BID
  • RECOMMEND TRIAL FOR 4-8 WEEKS, CAN THEN TRY DECREASING DOSE

INFLAMMATORY BOWEL DISEASE

- INFLAMMATION OF THE GASTROINTESTINAL LINING DUE TO AN OVERACTIVE IMMUNE RESPONSE.

- ALTERATION IN MICROBIAL COMPOSITION
  - INCREASE IN BACTERIA THAT PRODUCE PRO-INFLAMMATORY MOLECULES
  - DECREASE IN BACTERIA THAT HAVE A DAMPENING EFFECT ON IMMUNE ACTIVATION

- RECENT META-ANALYSES SHOWED EFFECTIVENESS OF COMBINATION PROBIOTICS FOR BOTH INDUCTION OF, AND MAINTENANCE OF, REMISSION IN ULCERATIVE COLITIS

- VSL #3 - 2 CAPSULES DAILY (225 BILLION CFU) FOR 8-12 WEEKS FOR INDUCTION OR LONG TERM FOR MAINTENANCE OF REMISSION

- NO EVIDENCE FOR THEIR USE IN CROHN’S DISEASE

DIARRHEA

- COLONIZATION RESISTANCE: MECHANISM BY WHICH THE HUMAN INTESTINE IS PROTECTED FROM DIARRHEAL ILLNESS BY HEALTHY BACTERIA THAT BLOCK THE ACTIONS OF PATHOGENIC BACTERIA\(^1\)

- ANTIBIOTIC ASSOCIATED DIARRHEA: MICROBIAL BALANCE IS ALTERED BY ANTIBIOTIC USE.

  - RECENT META-ANALYSES HAVE SHOWN AN OVERALL RISK REDUCTION WITH THE USE OF PROBIOTICS FOR PREVENTION OF BOTH AAD IN GENERAL AND ALSO CLOSTRIDIUM DIFFICILE ASSOCIATED DIARRHEA.\(^2,3\)

DIARRHEA

• ACUTE INFECTIOUS DIARRHEA AND TRAVELER’S DIARRHEA
  • COCHRANE LEVEL EVIDENCE SHOWING THAT PROBIOTICS DECREASE THE DURATION OF A DIARRHEAL EPISODE BY 25 HOURS, DECREASE THE RISK OF THE EPISODE LASTING MORE THAN 4 DAYS BY 59%, AND LED TO ONE FEWER DIARRHEAL STOOL PER DAY BY DAY TWO OF THE INTERVENTION.¹
  • PROBIOTICS WERE SHOWN IN A META-ANALYSIS OF 12 STUDIES TO PREVENT 85% OF CASES OF TRAVELER’S DIARRHEA.

DEPRESSION

- A STATE OF CHRONIC LOW GRADE INFLAMMATION AND OXIDATIVE STRESS\(^1\)
- TRADITIONAL DIETS (MEDITERRANEAN AND JAPANESE) HAVE BEEN SHOWN TO CONFER A LEVEL OF PROTECTION AGAINST DEPRESSION\(^1\)
- FERMENTED FOODS FROM TRADITIONAL DIETS PROVIDE ANTI-INFLAMMATORY EFFECTS AND PRODUCE INCREASED GABA\(^1\)
- MECHANISMS THROUGH WHICH THE GUT-BRAIN AXIS IS THOUGHT TO IMPACT MENTAL HEALTH
  - MODULATION OF THE HPA AXIS
  - ACTIVATION OF THE IMMUNE SYSTEM
  - PRODUCTION OF ACTIVE METABOLITES
  - DIRECT INVOLVEMENT OF THE VAGUS NERVE\(^2,3\)

DEPRESSION

• DIFFERENCES IN PATTERNS OF BOTH OVER AND UNDERREPRESENTED MICROBIOTA SPECIES IN DEPRESSED PATIENTS

• ONE SMALL STUDY OF HEALTHY WOMEN SHOWED THAT A FERMENTED MILK PRODUCT WITH PROBIOTIC IMPACTED THE AREAS OF THE BRAIN THAT CONTROL EMOTION AND SENSATION ON FMRI.

• A FEW SMALL STUDIES HAVE SHOWN IMPROVEMENT IN DEPRESSION SCORES WITH PROBIOTICS.

OBESITY

• MULTIFACTORIAL PROCESS

• IN SETTING OF STABLE ENERGY CONSUMPTION AND ADEQUATE PHYSICAL ACTIVITY – PREVALENCE OF METABOLIC DISORDERS IS RISING

• ANIMAL DATA SHOWING THAT THE MICROBIOTA OF OBESE RATS CAUSE WEIGHT GAIN IN SETTINGS OF CONTROLLED CALORIE INTAKE
  • MECHANISM IS THOUGHT TO BE THROUGH INCREASED CALORIE BREAK DOWN AND ABSORPTION

• RECENT META-ANALYSIS OF 4 RCT’S SHOWED NO DIFFERENCE IN THOSE TREATED WITH PROBIOTICS FOR WEIGHT LOSS
  • 2 STUDIES NOT INCLUDED FOR POOR DESCRIPTION OF RANDOMIZATION WERE LONGER AND WITH HIGHER DOSES OF PROBIOTICS SHOWED POSITIVE RESULTS
  • POSSIBLE THAT FUTURE STUDIES WILL WITH HIGHER CONCENTRATIONS AND BETTER CONTROL FOR DIET WILL SHOW BETTER RESULTS

DIABETES

• HYPOTHESIS IS THAT DYSBIOSIS OF THE GUT FLORA
  • ACTIVATION OF PRO-INFLAMMATORY CYTOKINES
  • DISRUPTION OF THE INTESTINAL MUCOSA
  • LEADING TO SYSTEMIC INFLAMMATION AND GLUCOSE DYSREGULATION

• PROBIOTIC SUPPLEMENTATION STUDIES ARE SHOWING LARGELY BENEFICIAL EFFECTS ON GLYCEMIC CONTROLS ESPECIALLY IN ANIMAL STUDIES.

• THE LARGEST SYSTEMATIC REVIEW TO DATE LOOKED AT 33 STUDIES OF WHICH 5 WERE IN HUMANS.

• ALL OF THE STUDIES IN HUMANS SHOWED A SIGNIFICANT REDUCTION IN AT LEAST ONE PARAMETER OF GLYCEMIC CONTROL

• IT IS STILL UNCLEAR WHICH STRAINS CONFER THE MOST BENEFIT AND IF THOSE BENEFITS ARE SUSTAINABLE WITHOUT DIETARY AND ACTIVITY CHANGES.

PREVENTION OF URI

• EVIDENCE MIXED, BUT PROMISING

• COCHRANE REVIEW OF 13 RCTS WITH 3270 PARTICIPANTS COMPARING PROBIOTICS VS. PLACEBO FOR PREVENTION OF URI, DURATION OF SYMPTOMS
  • OVERALL, PROBIOTICS REDUCED NUMBER OF PARTICIPANTS WITH ACUTE URI, REDUCED RATE RATIO OF ACUTE URI, AND REDUCED ANTIBIOTIC USE BUT QUALITY OF EVIDENCE WAS LOW
  • DECREASED LENGTH OF URI BY 1.89 DAYS OVER PLACEBO
  • MOST BENEFICIAL STRAINS INCLUDED MIXED LACTOBACILLUS OR LACTOBACILLUS PLUS BIFIDOBACTERIUM

OTHER AREAS OF PROMISE

- ALLERGIC RHINITIS
- ASTHMA
- ADHD
- AUTISM
- CHRONIC FATIGUE
- CYSTIC FIBROSIS
- DENTAL DISEASE
- DIABETES
- DIVERTICULAR DISEASE
- FOOD ALLERGY
- GERD
- HYPERTENSION
- HYPERLIPIDEMIA
- LIVER DISEASE/HEPATIC ENCEPHALOPATHY
- RHEUMATOID ARTHRITIS
- NEPHROLITHIASIS
- NOSOCOMIAL/ICU INFECTION
- POST-OP INFECTION
- URI
CONCLUSION

• “EAT FOOD, NOT TO MUCH, MOSTLY VEGETABLES” – MICHAEL POLLEN

• FAVOR VAGINAL DELIVERY AND BREASTFEEDING

• EAT A DIET RICH IN FRUITS AND VEGETABLES.

• STAY ACTIVE

• CONSIDER ADDITION OF PROBIOTICS FOR CERTAIN CONDITIONS WHERE INDICATED
FOOD FERMENTATION

• THE CONVERSION OF CHO TO ALCOHOLS AND CARBON DIOXIDE OR ORGANIC ACIDS USING YEASTS AND/OR BACTERIA, OCCASIONALLY MOLD UNDER ANAEROBIC CONDITIONS.

\[
C_6H_{12}O_6 \rightarrow 2 C_2H_5OH + 2 CO_2
\]

• DESIRABLE GROWTH OF MICROORGANISMS
  • SUPPORTED BY METABOLISM OF NUTRIENTS IN FOOD
  • PRODUCTION OF ATP VIA GLYCOLYSIS
  • CONTROLLED CONDITIONS
  • ACID AND ALCOHOL PRESERVE FOOD AND PROVIDE FLAVOR
FERMENTED FOOD CATEGORIES

• **SOY** (TEMPEH, SOY SAUCE, TOFU, NATTO)
• **ALCOHOLIC BEVERAGES** (WINE, BEER, CIDER, SPIRITS)
• **BEVERAGES** (COFFEE, COCOA BEANS, TEA)
• **MEAT** (CHORIZO, PEPPERONI, SALAMI)
• **GRAIN** (BREAD, BEER)
• **VEGETABLES** (SAUERKRAUT, KIMCHI, PICKLES)
• **MILK** (YOGURT, KEFIR, BUTTERMILK, CHEESE)
FERMENTATION PURPOSES

- **ENRICHMENT** of the diet through development of a diversity of flavors, aromas, and textures in food substrates

- **PRESERVATION** of substantial amounts of food through lactic acid, alcohol, acetic acid and alkaline fermentations

- **BIOLOGICAL ENRICHMENT** of food substrates with protein, essential amino acids, essential fatty acids, and vitamins

- **FOOD SAFETY** - elimination of unwanted microorganisms
FOOD SAFETY – MICROBIAL GROWTH

- NUTRIENT AVAILABILITY
- WATER ACTIVITY
- PH
- OXYGEN
- TEMPERATURE
FERMENTATION “STARTERS”

• LACTIC ACID BACTERIA CULTURE
• YEAST
• MOLD
• EXOGENOUS ADDITION OR NATURAL COMPONENT OF FOODSTUFF
LACTIC ACID FERMENTORS

HOMOFERMENTORS
PRODUCE LACTIC ACID ONLY
• **LACTOBACILLUS ACIDOPHILUS**
• **LACTOCOCCUS LACTIS**

\[ C_6H_{12}O_6 \rightarrow 2 \text{CH}_3\text{CHOHCOOH} \]

HETEROFERMENTORS  \[ C_6H_{12}O_6 \rightarrow \text{CH}_3\text{CHOHCOOH} + \text{C}_2\text{H}_5\text{OH} + \text{CO}_2 \]
PRODUCE MORE THAN ONE COMPOUND
• I.E. ETHANOL, DIACETYL, LACTIC ACID, ETHANOL, ETC.
• **STREPTOCOCCUS THERMOPHILUS**
• **LEUCONOSTOC CREMORIS**
STARTER CULTURES

• POOLISH, BIGA, DESEM, SPONGE

• STARTS FERMENTATION PROCESS
  • SAMPLE OF PREVIOUS BATCH OF FERMENTED FOOD OR MICROORGANISMS
  • ADDED TO FOOD TO PRODUCE DESIRED PRODUCT
  • ADDING HIGH NUMBER OF ORGANISMS SPEEDS UP FERMENTATION PROCESS
  • SPECIFIC TYPE OF BACTERIA ADDED TO FOOD TO PRODUCE DESIRABLE PRODUCT
FERMENTED DAIRY PRODUCTS

- YOGURT
- SOUR CREAM
- BUTTERMILK
- CHEESE
- KEFIR
- KOUMISS
- ROPY MILKS
MILK – LACTIC ACID BACTERIA

- **LACTOCOCCUS** – FOUND PRIMARILY ON PLANTS
- **LACTOBACILLUS** – 50+ VARIETIES FOUND IN BOTH PLANTS AND ANIMALS
  - STOMACH OF MILK-FED CALVES
  - HUMAN MOUTH
  - DIGESTIVE TRACT
MILK FERMENTATION - OVERVIEW

- HEAT MILK
- COOL TO DESIRABLE TEMPERATURE
- ADD BACTERIA
- MONITOR TIME
- COOL FOR STORAGE
<table>
<thead>
<tr>
<th>Product</th>
<th>Region</th>
<th>Microbe</th>
<th>Temperature</th>
<th>Acidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yogurt</td>
<td>Middle east/India</td>
<td><em>Lactobacillus delbrueckii</em> <em>Streptococcus salvarius</em></td>
<td>106-114°F (2-5 hours)</td>
<td>1-4%</td>
</tr>
<tr>
<td>Buttermilk</td>
<td>Eurasia</td>
<td><em>Lactococcus lactis</em> <em>Leuconostoc mesenteroides</em></td>
<td>72°F (14-16 hours)</td>
<td>0.8-1.1%</td>
</tr>
<tr>
<td>Sour cream</td>
<td>Europe</td>
<td><em>Lactococcus lactis</em> <em>Leuconostoc mesenteroides</em></td>
<td>72°F (16 hours)</td>
<td>0.8%</td>
</tr>
<tr>
<td>Koumiss</td>
<td>Central Asia</td>
<td><em>Lactobacilli</em> <em>Yeasts</em></td>
<td>80°F (2-5 hours)</td>
<td>0.5-1%</td>
</tr>
<tr>
<td>Koumiss</td>
<td>Central Asia</td>
<td><em>Lactococci, lactobacilli, Acetobacter, Yeasts</em></td>
<td>68°F (24 hours)</td>
<td>1%</td>
</tr>
</tbody>
</table>
Series of steps in fermentation of milk to produce yogurt

110° F

Production of Formic acid

S. thermophilus

Stimulates growth

Lactic acid

pH ≤ 4.8

L. delbrueckii ss. bulgaricus

Stimulates growth

amino acids

Formic acid

pH = 5.5

S. thermophilus

Stimulates growth

L. delbrueckii ss. bulgaricus

Stimulates growth

Cooling and low pH stops growth
FERMENTATION OF MEAT (SAUSAGES)

• WHY? DEVELOPS FLAVOR OF PROTEIN AND FAT. PRESERVES MEAT WITHOUT NEED FOR REFRIGERATION

• CULTURE MUST BE APPROVED BY USDA

• TYPE OF BACTERIA USED TO FERMENT MEAT MUST BE:
  • SALT-TOLERANT
  • FROZEN UNTIL USE (10^6 CFU/GRAM)
  • ADDED AFTER CURING AND SEASONING
  • PRODUCE ACID AND PH CHANGE
    • GOAL PH<5.3
    • CONTROLLED BY AMOUNT OF SUGAR ADDED, TEMPERATURE, AND TIME
TYPES OF SAUSAGES

• NORTHERN
  • NORTHERN EUROPEAN VARIETIES
  • 40-50% WATER, 3.5% SALT, REFRIGERATED
  • SUMMER SAUSAGES AND GERMAN CERVALATS

• SOUTHERN
  • DRY, SALTY, WELL-SPICED TYPICAL OF WARM, DRY MEDITERRANEAN
  • 25-35% WATER, 4% SALT, STORED AT RT
  • SALAMI AND CHORIZO
MODERN SAUSAGE MAKING

• EUROPE ADDS NITRATES AND US NITRITES TO PREVENT BOTULISM
• FERMENTATION LASTS 18 HOURS – 3 DAYS
• TEMPERATURE DEPENDENT (60-100°F)
• PH 4.5-5.0
• SAUSAGE IS COOKED AND/OR SMOKED
• DRIED FOR 2-3 WEEKS TO DESIRED MOISTURE CONTENT
FERMENTING PRODUCE

• STARTER CULTURE COMPOSED OF NORMAL MIXED FLORA OF RAW VEGETABLE

Leuconostoc mesenteroides
Lactobacillus brevis
Pediococcus cerevisiae

Cabbage

Lactic acid, lowers pH
CO₂ creates and maintains anaerobic conditions

2.5% salt
64° F

Fermentation

Sauerkraut
FERMENTING ALCOHOL BEVERAGES

- **Beer** (Grains, primarily Barley)
- **Wine** (Fruit, primarily Grapes)
- **Spirits** or Distilled Beverages (Grains, Fruits or Other Cho Sources)
BASIC FERMENTATION IN DISTILLED BEVERAGES

- FERMENT CHO SOURCE WITH YEAST
- PRODUCE MODERATE ALCOHOL CONTENT (5-12%)
- DISTILL LIQUID TO CONCENTRATE
- MODIFY CONCENTRATED LIQUID (FLAVOR WITH SPICES, HERBS OR AGED IN WOOD BARRELS)
- ADJUST ALCOHOL CONTENT
Fermenting Grains: Beer Making

Malted barley (steep in water until it germinates) + Cereal grains → Mash (malt is heated and dried, cracked and steeped) → Wort → Hops (vine, *Humulus lupulus*) added to boiling wort to provide bitterness and aroma → Cooled Wort → Saccharomyces Cerevisiae (yeast) → Fermentation adds: Ethanol (flavor) CO₂ (carbonation) → Beer → Fermentation by-products: Organic molecules that contribute to a beer’s distinctive character.
FERMENTING FRUIT - WINE

White wines

1. grapes
2. Crushing / Destemming
3. Pressing
4. Settling / Racking
5. Fermentation
6. Clarification
7. Stabilization
8. Bottling
9. Aging
10. Juice lees
11. White grape pomace

Red wines

1. grapes
2. Fermentation
3. Aging
4. Lees
5. Red grape pomace

Lees

Dry run: 10/2023
FERMENTING OTHER BEVERAGES

- COFFEE
- COCOA
- TEA
CACAO BEAN FERMENTATION
FERMENTED SOY

• FERMENTED TOFU
  • MOLDS IN THE ACTINOMUCOR AND MUCOR FAMILY

• SOY SAUCE
  • CONDIMENT PRODUCED BY FERMENTING SOYBEANS WITH ASPERGILLUS ORYZAE OR ASPERGILLUS SOJAE MOLDS

• TEMPEH
  • (INDONESIAN) WHOLE SOYBEANS AND A FERMENTATION STARTER CONTAINING THE SPORES OF FUNGUS RHIZOPUS OLIGOSPORUS

• MISO
KIMCHI DEMO

• NAPA CABBAGE, SALT, RED CHILI PASTE, GREEN ONIONS, RADISH, CARROTS, GINGER, GARLIC, ETC...