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ARLETTE GÓMEZ ORTIZ

THE SCIENCE OF MEAD
A JOURNEY THROUGH HONEY, WATER, YEASTS AND TIME

Culture begins with cultivating the land, planting seeds, bringing intentionality to cycles that we act to perpetuate

–Sandor Ellix Katz. ***The Art of Fermentation***

Culture and Transformation

Tradition is strongly related to a specific environment; it creates a culture that can be evolving, adapting and changing through time. This idea of culture caught my attention, especially related to the living cultures that allow fermentation, conservation and transformation processes; granting us, humans, to rely on a more sustainable relationship with what we eat, drink and digest, accounting for the environment that surrounds us, time and observation. Culture is cultivation, but it is not an isolated act; it is, by definition, part of a cyclical ongoing process, passed on from generation to generation. [1]

Fermented foods and beverages have been found and researched in every culinary tradition. [2] That is the case for mead, an alcoholic beverage produced since ancient times, mainly in an empirical manner, as a result of a mix of honey and water. Despite the alcohol content in mead, that ranges between 8 and 18%, this drink has been reported to contain many of the elements which are essential to humans and to have excellent effects on digestion and metabolism. [3]

On one hand, the practice of traditional foods develops a higher level of wisdom on what has a positive impact on our bodies, which made me curious enough to start a fermentation process of my own. Food choices and changes in the environment, probably co-occurring, are generally cited as the most important forces in human biological and cultural evolution. [4] On the other hand, taste has played a fundamental role in what we put into our bodies. Amongst endless options we trust our senses to avoid toxic elements in nature –usually related to bitterness and acidity– and to look for sweet substances that include carbohydrates –an important source of energy–; amino acids –some of which have an umami taste (also found in fermented foods)–, and proteins. All these elements are fundamental for our metabolism because, in addition to making calories, they are our only source of nitrogen. [5]

Human health is strongly related to ancient and diverse food, our genes expect bioactive compounds that traditional, regional, and biodiverse ingredients provide;[6] with this in mind, and my particular interest in honey and how the varietals can trigger flavor, I started to dig into the traditional process of making mead, hoping to find the knowledge around this honey wine that unfortunately I haven't inherited.

Yeasts and honey: a reservoir of biodiversity

The process of yeasts fermenting sugars into alcohol is a natural phenomenon that does not require human intervention, although its a general consensus that alcohol was the earliest form of fermentation consciously practiced –and enjoyed– by humans;[7] hence we have been analysing and developing technologies and methods to satisfy our bodies and souls.

Yeasts are a bottomless reservoir of biodiversity, with more to offer than the classical handful of species traditionally used or studied.[8] [(*)] Yeasts are everywhere, we can find them in plants, fruits, leaves, flowers and exuded sap. All those elements are profoundly connected to honeybees and life inside the hive, from the nectar of flowers and the exuded sap –a raw material transformed by bees into honey and honeydew–, to the concept of bees preserving biodiversity and promoting life of plants, flowers and fruits.

Raw honey –produced by *apis mellifera*– contains abundant and inactive yeasts, due to the low moisture percentage that honey must contain when harvested. According to the International Honey Commission standards, moisture content (MC) shall be in a range that goes from 15% to 20%. Natural fermentation in honey starts when the MC is above 20.9%. [9] That usually means honey was harvested at an early stage, or that the humidity of the environment is extremely high and bees were unable to reduce the moisture ventilating with their wings.

Other species of bees that produce honey around the world –such as *meliponini,* stingless bees native to Central and South America and Southeast Asia–, present a moisture content that goes around 31.2% to 42% [10], allowing faster fermentation when transforming it into mead. According to PhD William Litzinger research, in Mayan culture, this beverage is called *baälche* and it is fermented in hollow log vessels called canoa, with a proportion of approximately 17 parts water to each part of honey, and adding a considerable quantity of bark from the *Lonchocarpus violaceus* tree. The measuring is done in a special ceramic –*The pot of the wine god*–, that is transferred from generation to generation of *baälche* (mead) makers within the family, Litzinger tested samples scraped from the interior of these pots and found high counts of a common yeast that allows the transformation of honey into wine, *S. Cerevisiae*. [11]

[(*)]Research from the microbiologists Ann Vaughan-Martini and Alessandro Martini, quoted by Sandor Katz in his book, *The Art of Fermentation*

Since the 1980's, standard industrial practices control the growth of yeasts naturally present in raw honey by pasteurizing it, removing its natural texture, aroma and taste notes. By creating a homogeneous and stable product, industrial processes destroy yeasts and enzymes naturally found in honey. [12]

Although there are different approaches to mead, I found that the vast majority of mead brewers use lab-made yeasts, *Saccharomyces Cerevisiae*, and other variations from the wine or beer industries. These methodologies[(*)] have something in common: heating honey and water, relying on lab-made yeasts to produce mead; rather than letting honey's own spontaneous yeasts thrive during the process.

Nonetheless, thanks to authors Jereme Zimmerman[13] and Sandor Katz[14], who state that fermentable sugars, in raw form, are already populated by yeasts, I was inspired to experiment with the process of spontaneous fermentation of honey and wild flowers, through their methodologies and approaches based on curiosity, observation and appreciation of diversity aligned with the environment I am immersed in.

Brewing Dandelion mead: a personal attempt

Choosing the origin and source of honey plays a vital role in the process of brewing mead, because the aroma of that particular honey selected will be enhanced by the process of fermentation and aging. For my first attempt of home brewing, I chose Dandelion honey (beekeeper Maria Paola Pelissero), one of my favorite Italian honey varietals for several reasons: it presents a dry and vegetal aroma that resembles a sweet chamomile infusion, it's gorgeous yellow color that will be evolving during the process, and because it is a Piedmontese ingredient from Slow Food, Ark of Taste.[15]

Thus my selection was based on personal preference, it is also interesting to choose an analysed honey varietal, this will throw important information of its composition, such as pH, water, fructose and glucose content, allowing to make conscious decisions during the fermentation process. According to the *European Unifloral Honeys* published by *Apidologie*, Dandelion *(Taraxacum Officinale)* represents one of the earlier nectar sources for bees, even though the pollen is under-represented and rarely goes beyond 50%, the sensory and physicochemical patterns are very characteristic. This honey shows low values of acidity, and high values of glucose, fructose+glucose and glucose/water ratio.[16]

[(*)]Morse, Roger A. 1980. *Making Mead (Honey Wine): History, Recipes, Methods and Equipment*. Wicwass Press.
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Sensory description		
Visual assessment	*Colour intensity*: medium	
	Colour tone: bright yellow	
Olfactory assessment	*Intensity of odour*: strong	
	Description: spoiled	
Tasting assessment	*Sweetness*: medium	*Acidity*: medium
	Bitterness: absent to weak	*Intensity of aroma*: strong
	Description of aroma: woody and spoiled	
	Persistence/aftertaste: long	
	Other mouth perceptions: when crystallised with very small crystals, refreshing (like "fondant")	
Physical characteristics	*Crystallisation rate*: quick *Other*: this honey is often found in a crystallised form with very small crystals; in this case the colour appears faint yellow (like custard)	

Table 1. Sensory description of Dandelion (*Taraxacum)* Honey. 2004. *Main European unifloral honeys: descriptive sheets.*

Taraxacum honey (114 samples; 1131 data)

Melissopalynological parameters	Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data
Data 129				Min.	Max.		
Specific pollen	%	17.2	11.7	5.0	40.5	85	1 CH 26 1 D 15 2 I 44
Pollen absolute number	PG/10 g·10^3	33.6	15.3	7.8	63.0	44	2 I 44

Physicochemical parameters	Unity	Mean	St. Dev.	Limit of confidence 95%		Number of data	Lab Countries Data
Data 1002				Min.	Max.		
Color	mm Pfund	56.6	10.4	41.0	71.0	45	2 I 45
Electrical Conductivity	mS/cm	0.51	0.07	0.37	0.65	105	1 B 5 1 CH 26 1 D 16 2 I 58
Specific Rotation	$[\alpha]_D^{20}$	−10.0	2.1	−13.9	−5.9	54	2 I 54
pH		4.5	0.2	4.0	4.9	74	1 B 5 1 CH 26 2 I 43
Free Acidity	meq/kg	10.9	2.0	6.8	14.9	58	1 B 5 1 CH 14 2 I 39
Lactones	meq/kg	1.5	2.3	0.0	6.1	44	1 B 5 2 I 39
Total Acidity	meq/kg	12.5	2.7	7.4	17.1	44	1 B 5 2 I 39
Water	g/100 g	16.2	1.1	14.4	18.3	60	1 B 5 1 CH 26 1 D 16 2 I 13
Diastase (*)	DN	11.3	2.3	6.6	14.5	26	2 I 26
Invertase (*)	U/kg	110.7	28.9	58.5	166.0	45	1 B 3 1 D 16 2 I 26
Proline	mg/ kg	348	60	255	469	36	1 CH 14 1 D 16 2 I 6
Fructose	g/100 g	37.4	1.8	33.8	41.0	74	1 B 3 1 CH 26 1 D 17 2 I 28
Glucose	g/100 g	38.0	2.8	32.4	43.5	74	1 B 3 1 CH 26 1 D 17 2 I 28
Sucrose	g/100 g	0.4	0.6	0.0	1.5	59	1 B 3 1 CH 26 1 D 5 2 I 25
Fructose + Glucose	g/100 g	75.2	3.9	67.6	82.9	74	1 B 3 1 CH 26 1 D 17 2 I 28
Fructose / Glucose		0.99	0.07	0.85	1.13	74	1 B 3 1 CH 26 1 D 17 2 I 28
Glucose / Water		2.33	0.15	2.03	2.63	56	1 B 2 1 CH 26 1 D 15 2 I 13

(*) only for fresh honeys

Table 2. Physicochemical parameters of Dandelion (*Taraxacum)* Honey. 2004. *Main European unifloral honeys: descriptive sheets*

Honey contains both fructose and glucose, whilst glucose is transformed into alcohol during the first ten days of fermentation, fructose will continue slowly fermenting for many months.[17] The average balance of fructose (37.4 g/100g) and glucose (38 g/100g) in dandelion honey [18] will make the fermentation process interesting to analyse, I will keep my notes and experimenting with other honey varietals from the *European Unifloral Honeys Issue* to compare fermentation time, flavor and alcoholic rate.

Now the process of making mead will be presented, it's a documentation of my own experience, together with current research and scientific findings in the area.

- **Day 1:** For my first attempt at brewing mead, I followed the proportion suggested by Sandor Katz,[19] one part of raw honey dissolved into four parts of water at room temperature in n wide-mouth jar with a cloth covering it to avoid sunlight and bugs. During the first ten days, it is crucial to stir vigorously and constantly –I set an alarm to do it every two hours from 8 to 22h–, these aerations help stimulate yeast growth in a biodynamic way.
- **Day 2:** I went foraging dandelions, daisies and elderflowers, to add them to my mix of honey and water. According to Katz research, in many traditions –like in Ethiopia the *T'ej,* and in Mexico the *Baälche*– mead is enhanced by botanical ingredients. This approach is not only a quest for flavor but also provides tonic and medicinal properties. Moreover, plants are an important source to add acids, tannins, nitrogen and phytochemical growth factors to stimulate yeast growth. [20]

- **Day 3:** With flowers incorporated to the process, a glimpse of bubbling started to appear, indicating the first transformation of glucose into carbon dioxide and alcohol.

- **Days 4 to 7:** The first vigorous stir of day four, stimulates more bubbling, during the following five days bubbles begin to subside. I kept stirring and tasting constantly, noticing that acidity started to flourish.

- **Day 8:** Jereme Zimmerman suggests in his book a list of basic botanical ingredients to balance the sweetness of mead and experiment different tastes. Instead of using lab-made tannins and acids from the brewery and wine industries, he encourages to experiment with the local botanical biodiversity, and to taste the mead along the aging process and adjust according to what you want to achieve.[21] So, on day eight I added some black tea leaves and let them infuse my dandelion mead, this will add tannins to the mead and reduce sweetness once aged.

Tannins and Acids	Botanicals
Tannin	Oak and cherry bark and leaves (and those of other deciduous trees), grape stems, grape leaves, black tea, nettles, fruits (particularly tart and unripe fruits), berries, nuts, red and black beans, spices, coffee beans, hops, grain husks
Malic Acid	Most fruits (varying degrees of acidity), apples, mayhaws, nectarines, cherries, lychees, bananas, mangoes, peaches, tomatoes, strawberries, grapes, kiwis, watermelon, plums, limes, orange peels, rhubarb, pineapples, carrots
Citric Acid	Lemons, limes, oranges, clementines, tangerines, grapefruit, berries (not blueberries), tomatoes, rhubarb, lettuce, carrots, sourdough bread
Tartaric Acid	Avocados, cherries, grapes, lemons, plums
Ascorbic Acid	Rose hips, hibiscus, citrus fruits, spinach, tomatoes, berries

Table 3. Botanicals containing acids, tannins and nutrients. 2015. *Make Mead like a Viking*

- **Day 10:** After the first ten days of fermentation, the mead is ready to enjoy "green" (unmature), with a low alcoholic concentration. The flavor has already evolved a lot since the extremely sweet water from the first day. Although it's still sweet, the complexity of taste notes that this short amount of time and nature has brought to it is very interesting. Based on my personal experience tasting honey, I can perceive it's acidity and body, fresh green and floral notes, a persistent aftertaste with a characteristic hint of chamomile from dandelion honey, and slightly fizzy.

- **From day 11 onwards:** Although I was already pleased with the flavor, and absolutely amused by the process, I decided to let my mead ferment its fructose slowly for a few more months. To achieve that, I transferred it to a 4l. carboy, and added more plain water to reduce the air surface. This will protect the surface of the ferment with oxygen in the air. The reason for this is the widespread presence of *Acetobacter* bacteria, that metabolize alcohol and oxygen into acetic acid (vinegar).

While the fermentation is vigorous (first ten days), there is a constant release of carbon dioxide that prevents this bacteria from forming on the surface; when the fermentation slows and there's no longer a vigorous stirring, there's a chance for *Acetobacter* to grow. At this stage, it is important to close the carboy with an airlock enabling CO_2 pressure to release slowly whilst protecting the mead from the outside flow of oxygen. Otherwise, the carboy may shoot out the plug lid or even explode. [22]

After a couple of months, this dandelion mead will be ready for racking by siphoning into a new carboy, this procedure will bring air and movement to the fermentation process, leaving behind the lees (sediment). Before sealing with an airlock in the new carboy, it is necessary to add a little bit of fresh honey and water to cover for the space the lees left behind and to avoid *Acetobacter* to form. Around six months shall pass until I start noticing that there's minimal or no signal of carbon dioxide in the airlock. At this stage, time and observation will be key to determine if it's ready for bottling and aging.[23]

Perception, time and resilience

"It's easier to change our food environment than to change our minds"

—Wansink Chandon

The magic of this process is that you can drink the mead at any stage after the first ten days, and enjoy how flavor changes through time. The perception of flavor and time can be connected to the idea of passing down a culture through generations, or, in a shorter perspective, one's own taste development and understanding of flavors.

Although it's been around six years since I started the journey to change my food environment, somehow consciously immersing myself into the world of fermentation has produced a profound mind shift. Suddenly the idea of resilience produced by cultures, fermentation and foraging, brought to my life the lense of preservation, providing a different level of awareness for my food choices, enhancing the value of biodiversity and resilience.

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