

Tannin Additions to Improve the Quality of Hard Cider Made from Dessert Apples

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With a recent revival in the hard cider industry, New York State is uniquely poised to take advantage of this growing trend. Since the cider industry still represents a very small

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percentage of the total market, consumer expectations for cider are mostly unknown or driven by a few key market players. The craft cider market in

particular has been responsible for much of the innovation in this sector, and there is renewed interest in high-quality imported ciders from the United Kingdom, Spain, and elsewhere, that tend to be less sweet and more astringent.

Most ciders are a result of blending several different apple varieties, since unlike wine grapes, very few apple varieties have the perfect balance of sensory characteristics. The astringency of cider is a reflection of the apples used to produce it, which in the case of mass-market cider, utilizes primarily two types of apples: sharps (tart) and sweets (also known as “desserts”). Both of these types are low in tannin and thus impart little to no astringency in the final cider product. The two other types, bitter-sharps and bitter-sweets, are high in tannins and are blended along with sharps and sweets to make a final product that is more astringent and higher in total phenolics (TP).

Bittersharp and bittersweet apples (“cider apples”) are infrequently found in the open market due to their high levels of astringency, which make them unpalatable as an out-of-hand apple. Their use in traditional ciders, however, is indispensable, as they contribute to the structure, preservation, finish, and perceived complexity of the cider. Dessert apples, the ones commonly found in supermarkets, have a long history of steady demand from both consumers and processors and are the primary apples that New York State produces. As a result, there is a shortage of cider apples for making quality hard cider, and increasing production of these varieties is challenging, particularly in the short term.

For New York State cider producers looking to take advantage of the increased popularity in cider, one option is to fortify cider with added tannins, either in powdered or liquid form. The most popular sources for these tannin additions, which are primarily used in wine, are grape skins and seeds, arboreal tannins from varieties of tree bark, and nut tannins such as chestnut and gail nut. There are few, if any apple-derived tannins for the cider-

maker looking to increase the astringency in their cider aside from growing cider apples, which presents an opportunity for utilization of spent pomace for apple tannin production.

Consumer Expectations for Cider

Due to the evolving nature of the cider market in the United States, it is likely that consumer preferences are evolving in tandem. To evaluate this hypothesis, a consumer survey was conducted in the tasting room of a winery that sells both wine and cider. A majority of the participants ($n = 50$) had consumed cider no more frequently than a couple of times a year (64%). The results showed that the average consumer preferred sweet cider to dry cider (56%), and preferred wine to other alcoholic beverages (52%). As anticipated, the majority of participants were not familiar with hard cider apple varieties. When asked which apple would be of most interest if made into hard cider, Honeycrisp ranked highest among a group of more exotic or lesser known varieties such as Kingston Black, Tremlett’s Bitter, or Orange Pippin. Finally, those tested emphasized the price, place of production (specifically local production) and the recommendation of friends when making purchasing decisions about cider. The results show the need and the opportunity to educate consumers regarding apple varieties for cider production and the range of styles available to meet different consumer expectations.

Those in the age group 21 to 34 ($n = 15$) were the most likely to read the back information panel and the most willing to try unknown apple varieties. This age group also had a balanced preference for sweet and dry ciders and placed very little importance on the brand of the cider. For participants older than 35, there was a strong tendency towards sweet ciders, familiar apple varieties, and an emphasis on price when making purchasing decisions. These results are consistent with observed market trends of transparency in labeling for all age groups and more adventurous purchasing in millennials, the largest generational group of individuals born between 1980–2000. All age groups valued local production highly when purchasing cider, second only to the recommendation of a friend, which further emphasizes the role of consumer education and communication to promote cider purchases.

Sensory Evaluation of Cider Blends with Added Tannins

We were interested in assessing the acceptability of the addition of endogenous and exogenous tannins to cider made from dessert apples, to increase the astringency and complexity of the final cider. To do so, fermented cider was produced from dessert cultivars commonly grown in New York State: Empire, Jonagold,

Ida Red, and MacIntosh. Fermentation was carried out with Lallemand DV-10 yeast supplemented with a mixture of organic (Go-Ferm, Fermaid-K) and inorganic nitrogen (diammonium phosphate) at ambient temperature of 16°C for about 21–28 days, until no sugar remained. Sulfite levels were kept at 30–50 ppm. This base blend (first control sample) was then tannin-enriched with 150 ppm total phenolics as mg gallic acid equivalent (GAE)/L using 3 treatments: addition of 20% fermented cider made from high-tannin cider apples (endogenous), and two commercially available exogenous powdered tannins: grape tannin UVA Soft from Scott Labs at 278 ppm (54% calculated retention), which is recommended for white wines; and gall nut from Scott Labs at 179 ppm (84% calculated retention) recommended for cider and

white wines. The two powdered tannins were selected as the best options after evaluating several commercial products for suitability in ciders. The cider apples chosen, Harry Masters Jersey and Dabinett, are being used by many NY state cider producers due to their medium to high levels of tannins. In previous studies, we had identified a commercial cider that received high consumer acceptability and thus was used as an additional control to be evaluated against our four treatments. The four prepared samples were normalized to conditions we had optimized for residual sugar at 3%, pH 3.5–3.6, and carbonation at 1.5–2.5 volumes of carbon dioxide. Prepared ciders (Figure 1) were bottled and kept refrigerated until the sensory trial.

We recruited 193 participants from the Cornell Sensory Center database by promoting the study and offering a small payment reward. The sensory studies were conducted following all the requirements of the Institutional Review Board of Cornell University regarding beverage samples for consumption. For each sample, the participants evaluated appearance, color, aroma, flavor, carbonation, and overall liking on a 9-point hedonic scale (from “Dislike extremely” to “Like extremely”). They also evaluated the qualities of sweetness, acidity, astringency, carbonation, and apple flavor on the 5-point Just-About-Right (JAR) scale (1, “Not Enough”; 3, “Just-about-right”; 5, “Too Much”). The JAR scale is useful in determining which attributes of a product are not optimal and that their alteration would potentially have a large impact on liking of the product in question. The research was conducted over 3 days at the Sensory Evaluation Center at Cornell University.

No significant differences in overall liking were observed between the four samples with endogenous and exogenous tannins; however, all received positive hedonic ratings, significantly higher than the commercial cider (Figure 2). Astringency was just-about-right for all prepared samples, demonstrating a wide range of astringency acceptability, and that the three different sources of tannins were equally acceptable (Table 2). The penalty analysis also revealed that the blend with high-tannin cider apples was penalized heavily for its appearance among non-cider drinkers. Subsequent analysis revealed the sample to be



Figure 1. Bottled ciders prepared at the New York Experiment Station in Geneva. A base cider “control” tannin enriched with three treatments: 20% cider from high tannin apples “cider”, and two commercial tannins “Ft” and “Uva Tan”

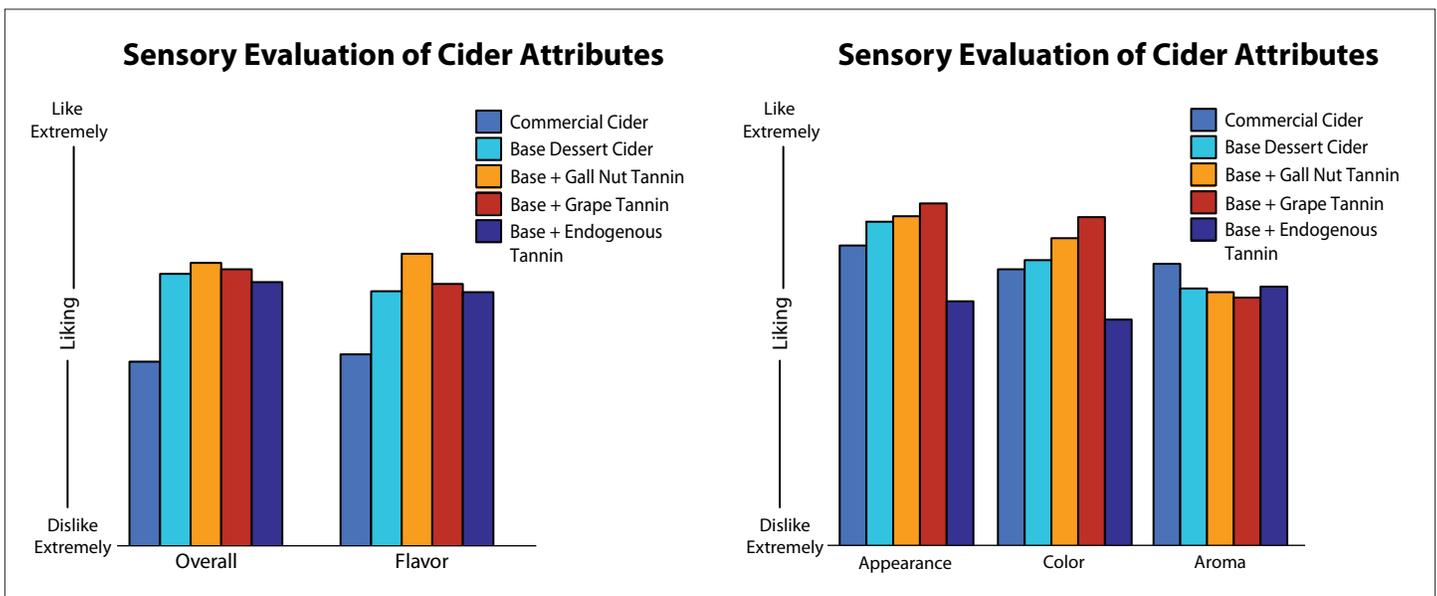


Figure 2. Hedonic results of sensory evaluation of cider blends with added tannins.

significantly more turbid than the other 4 samples (Table 1).

Among non-cider drinkers, the expectation appears to be for a perfectly clear product, whereas experienced drinkers are accustomed to some sediment in some high-quality ciders. The positive acceptability of these ciders confirms our previous work on an “ideal” cider that balances consumer expectations with regard to sweetness, level of tannins, acidity, and carbonation. These results are very encouraging, as they demonstrate the capacity to make quality ciders with dessert apples and that different styles can be developed just by adding tannins to the cider. Commercially available powdered tannins that are carefully selected and added at optimal concentrations to cider can be successfully used to reach the same level of complexity and astringency obtained from using a blend of dessert apples and hard cider apples. The only exception was for “apple flavor.” In all five samples, more than 1/3 of panelists felt the samples were not sufficiently apple-flavored. An option to increase the apple character of the final cider is to add apple juice or concentrate to reach the optimal 3% residual sugars.

After completing the survey, sensory panelists were asked to assess their willingness to pay for a 750-mL bottle of the cider they selected as being the most liked now, knowing that it was locally produced from a blend of NY apples (Figure 3). A 750-mL bottle was chosen due to its popularity among local craft ciders. In contrast to wine and beer, which come in predictable volumes of a 12-oz can or a 750-mL bottle, cost comparisons for cider can be challenging due to its variable packaging options. As such, a picture of a 750-mL bottle and its equivalent in ounces was provided to assist in making this comparison.

The initial bid given to participants was \$11.00 followed by a second bid of \$13.00 if the initial bid was affirmed and \$9.00 if it was denied. This partitioned the total willingness to pay into four intervals: (1) less than \$9.00 (8% of panelists), (2) between \$9.00 and \$11.00 (15% of panelists), (3) between \$11.00 and \$13.00 (32% of panelists), (4) at least \$13.00 (45% of panelists). From this information, the average willingness to pay was calculated at \$12.74, which for a bottle of craft cider in New York State is very typical. This number may be underestimated for two reasons. First, a plurality of respondents was in the highest bid category, suggesting that an even higher bid range

Table 1. Chemical composition of ciders used in sensory evaluation.

Ciders	Total Phenols (ppm GAE)	pH	Acidity (malic) g/L	CO ₂ Volumes	Brix°	Turbidity (NTU)	Ethanol (v/v)
Commercial Cider	814	3.70	5.36	3.30	8.57	1.12	6.60%
Base Dessert Cider	275	3.59	6.84	2.34	8.20	4.84	6.60%
Base + Endogenous Tannin	540	3.58	5.77	1.83	8.08	16.63	6.60%
Base + Grape Tannin	478	3.67	5.90	1.60	9.93	6.71	6.30%
Base + Gall Nut Tannin	471	3.54	6.03	1.85	8.32	5.44	6.30%

Table 2. Just-about-right (JAR) attribute results for sample treatments. Samples were deemed JAR if the response percentage was greater than 70% or if there was no significant difference at $p < .05$ between the other levels of “Too much” or “Too little”.

Treatment	Sweetness	Acidity	Apple Flavor	Carbonation	Astringency
Commercial Cider	Too little	Too much	Too little	JAR	Too much
Base Dessert Cider	Too little	JAR	Too little	JAR	JAR
Base + Gall Nut Tannin	Too little	JAR	Too little	Too little	JAR
Base + Grape Tannin	Too little	Too much	Too little	Too little	JAR
Base + Endogenous Tannin	JAR	JAR	Too little	Too little	JAR

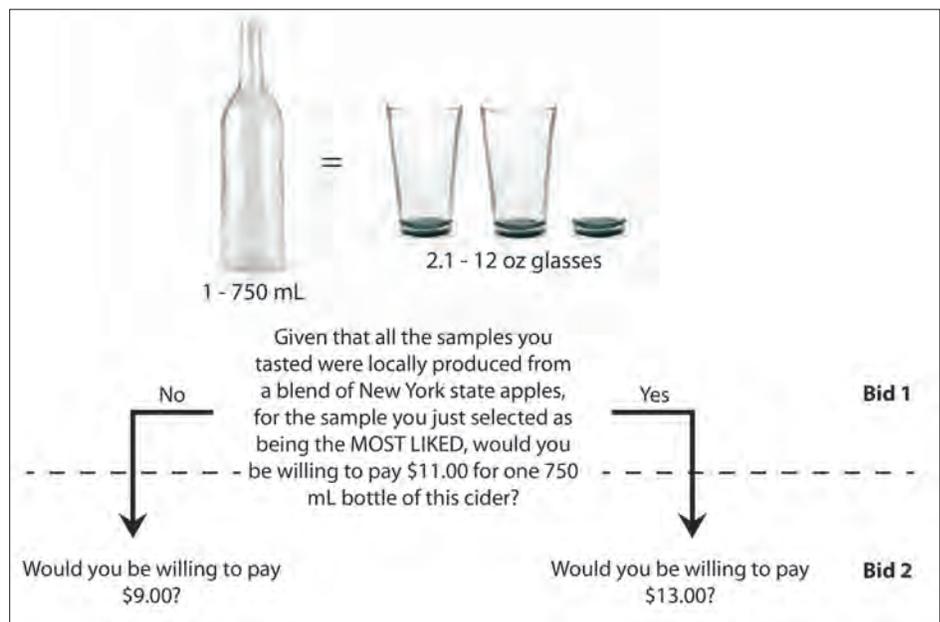


Figure 3. Illustration of “Willingness to Pay” estimation as posed in cider sensory study with initial and follow-up bids.

may have been suitable. Secondly, a majority of the panelists indicated that they were students (76%) and as such, had below average incomes (Table 3), thereby depressing their ability and possibly willingness to pay.

Table 3 summarizes the demographics of the panelists. Noticeably, 85% were millennials who tend to be more open to new products. This was confirmed when panelists were asked whether they would be likely to purchase a bottle of cider they had never purchased before, and 42% stated they would be likely or very likely to do so. Brand familiarity was also assessed by inquiring about individual commercial and local brands. While, as anticipated, many of the commercial brands were recognized, several local brands that have distribution only in New York or the Northeast had similar recognition scores.

Future Work

Based on the positive results obtained from our studies on tannin addition to cider, we are now focused on producing a tannin-rich extract from apple pomace to increase astringency and overall quality of ciders made from dessert apples. Our aim is to have an extract that would be comparable or superior in quality to other commercial products being offered for alcoholic beverages. We are evaluating using the pomace from both dessert and hard cider apples as the source of apple tannins. The production process will be designed with sustainable and affordable technologies.

Summary

As competition continues to grow in the cider industry, innovation and sustainability are a must. The continued rising

Table 3. Summary of sensory panel demographics (n = 193).

Variable	Description	Frequency (%)
Gender	Male	29
	Female	71
Age	21-34	85
	35-44	10
	45-54	3
	55+	2
Income	<\$20,000	24
	\$20,000-\$29,999	15
	\$30,000-\$39,999	18
	\$40,000-\$60,000	10
	\$60,000-\$100,000	10
	>\$100,000	6
	Prefer not to answer	17

demand for local and craft products will continue to buoy the New York cider industry. Understanding customer expectations for transparency, variety, and local production will help to meet those demands. Tannin fortification of ciders made from dessert apples increases complexity and quality of the final ciders. Successful options to achieve higher levels of tannins include blending with ciders made from high tannin varieties, or adding commercially available tannins currently used for other alcoholic beverages. Ongoing research on production of tannin-rich extracts from apple pomace will provide a new alternative for the cider industry.

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