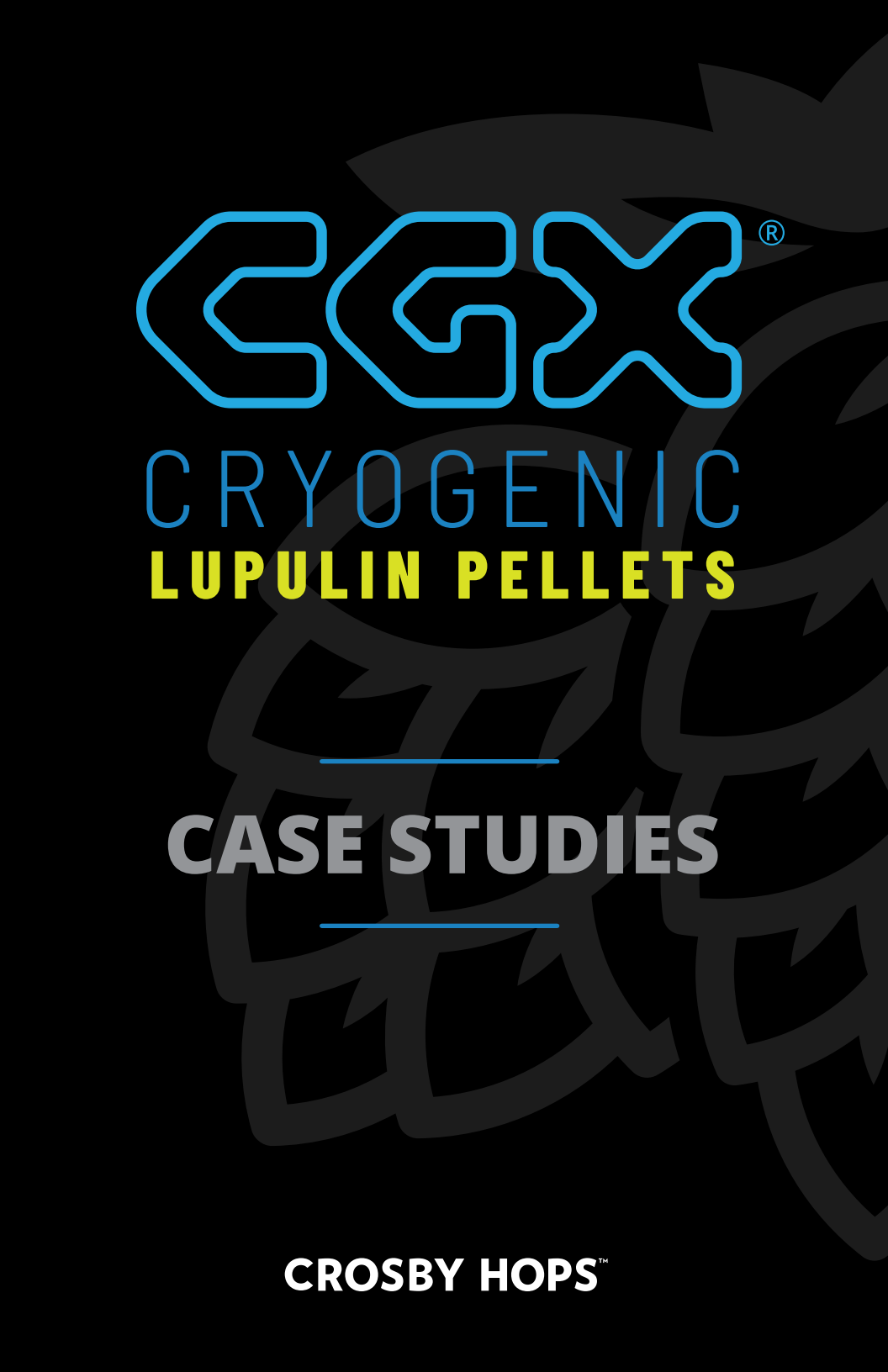


A large, dark gray, stylized hop cone is centered in the background of the entire page. It has a textured, segmented appearance.

CGX®

CRYOGENIC
LUPULIN PELLETS

CASE STUDIES

CROSBY HOPS™



CGX[®] CRYOGENIC LUPULIN PELLETS

CROSBY HOPS™

Pacific Northwest Headquarters

18564 Arbor Grove Rd NE

Woodburn, OR 97071

503-982-5166

crosbyhops.com

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Note: These case studies are ongoing and will continue to be updated. As more data is received over the coming months, we will amend conclusions as necessary regarding long-term QC evaluations.

CASE STUDY 1

Breakside Brewery RAINBOWS & UNICORNS

Session IPA

To better understand the effects of **CGX® Cryogenic Lupulin Pellets** on beer, **Crosby Hops** collaborated with national and international award-winning **Breakside Brewery** of Portland, Oregon on a case study to measure the impact of CGX on finished beer.

Ben Edmunds, Brewmaster and this year's recipient of the Russell Schehrer Award for Innovation in Craft Brewing, organized this study using Breakside's method of new ingredient introduction for production beer recipes. Capturing data from three 120-barrel batches of Breakside's **Rainbows & Unicorns** Session IPA, we sought to discover:





How does incorporating **CGX® Cryogenic Lupulin Pellets** in a production beer recipe influence the below measurables compared to a 100% T-90 version of the same recipe?

- **Finished beer yield**
- **Beer stability**
- **Overall sensory impact**

Hop Varieties Measured



- **El Dorado® CGX®**
- **El Dorado® T-90**
- **Strata®**
- **Strata® T-90** (an Indie Hops variety)

Background

- **Batch Size:** 120 barrels (x3)
- **Strata® CGX** and **El Dorado® CGX Cryogenic Lupulin Pellets** were treated as having a **2:1** impact of T-90 pellets in the whirlpool and dry hop
- **Rainbows & Unicorns** uses slightly less than 3 pounds of hops per barrel
- **Rainbows & Unicorns** is already a high-yielding beer for Breakside Brewery



CGX® & T-90 Additions

- **By Weight**

Whirlpool	➔	80% T-90, 20% CGX
Dry Hop	➔	78% T-90, 22% CGX

- **By Impact**

Whirlpool	➔	67% T-90, 33% CGX
Dry Hop	➔	64% T-90, 36% CGX

- **Dry hop per 120-barrel batch**

El Dorado T-90	44 pounds
El Dorado CGX	33 pounds
Strata T-90	44 pounds
Strata CGX	22 pounds

Key Discoveries

- 3% increase in finished beer yield
- Lower FAN levels in finished beer
- High initial flavor and aroma intensity scores

Conclusion

By replacing T-90 pellets with CGX in the whirlpool and dry-hop at 33% and 36% by impact respectively, **Breakside Brewery was able to increase finished beer yield by 3% and potentially achieve better beer stability due to lower FAN levels while retaining the flavor and aroma qualities that make Rainbows & Unicorns an award-winning beer.** Aroma intensity scores were also above average for the first 20–30 days compared to 100% T-90 versions of the same recipe.

Due to Breakside's refined process to achieve high efficiency with Rainbows & Unicorns already, **CGX has the potential to increase yields across a variety of hop-forward beers**, especially at higher hopping rates above 3 lbs per barrel. Theoretically, the higher hopped the beer, the greater the yield increase when replacing T-90 pellets with CGX in whirlpool and dry hop applications at the observed dosage rate.



*Using CGX pellets in place of some T-90 in these batches of Rainbows & Unicorns led to beers with a **clean mouthfeel and an elevated, lasting hop aroma intensity**. Even when used at modest levels, it seems that **CGX can be a powerful tool in helping us refine aroma and improve stability in all of our hoppy beers.***

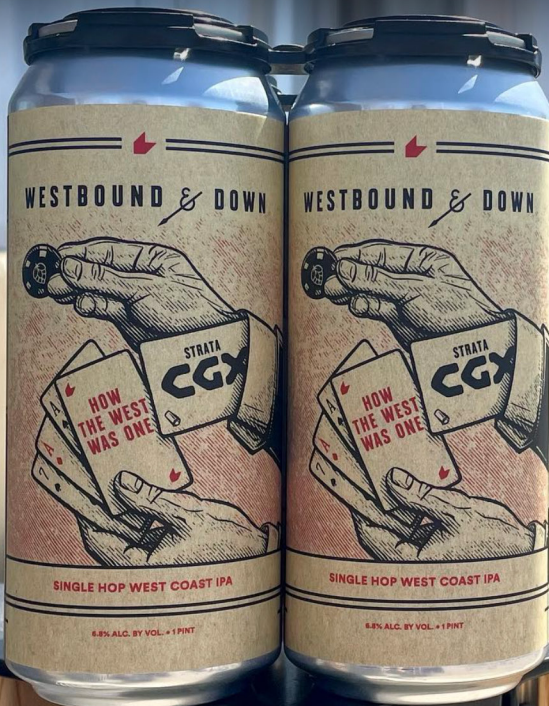
Ben Edmunds

Brewmaster, Breakside Brewery

CASE STUDY 2

Westbound & Down Brewing Company HOW THE WEST WAS ONE: STRATA® CGX® Single Hop West Coast IPA

To better understand the effects of **CGX® Cryogenic Lupulin Pellets** on beer, **Crosby Hops** collaborated with 2019 GABF Mid-Size Brewpub of the Year **Westbound & Down Brewing Company** of Idaho Springs, Colorado on a case study to measure the impact of CGX on finished beer. By capturing data from **How The West Was One**, a rotating single-hop West Coast IPA, Jake Gardner, Brewmaster, organized this study to measure the following:





How does incorporating **CGX® Cryogenic Lupulin Pellets** in a production beer recipe affect post dry-hop pH?

Hypothesis

Using CGX in whirlpool and dry hop applications will result in a lower pH in finished beer compared to a 100% T-90 batch due to reduced vegetal load. Lower pH results in a higher intensity hop sensory experience and better hop aroma shelf stability.

Hop Varieties Measured



- **Strata® CGX®**
- **Strata® T-90** (an Indie Hops variety)

Background

The data measured is a comparison of two batches:

- 1. How The West Was One: Strata® T-90**
- 2. How The West Was One: Strata® CGX**

Both batches were brewed as “oversized singles” meaning one 15-barrel turn at high gravity then liquored back at the end of boil to the desired whirlpool volume of 25 barrels. Each batch was fermented in identical 30-barrel fermentation vessels and transferred to identical 30-barrel brite tanks for equal measurement and comparison.



Given their experience in substituting T-90 pellets with other concentrated hop products, **Westbound & Down** chose to use a **multiplier of 1.5x** for impact pounds both in the whirlpool and dry hop calculations.

- **Batch Size:** 25 barrels each (CGX and T-90 respectively)
- **Strata® CGX was treated as having 1.5x the impact of T-90 pellets** both in the whirlpool calculations (bitterness was adjusted with first wort additions to achieve identical IBUs) and in the dry-hop additions
- **Westbound & Down typically sees a rise of 0.2 pH to 0.3 pH in post dry-hop pH in non-CGX beers**

Key Discoveries

- **The Strata CGX beer caused a 0.17 pH rise from pre-dry hop to post-dry hop compared to a 0.27 pH rise in the 100% Strata T-90 version**
- **4.8% increase in finished beer yield**

Conclusion

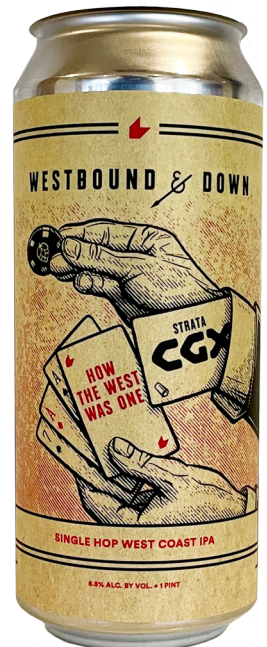
The hypothesis that less vegetal matter decreases post-dry hop pH was accurate. **By substituting CGX as a percentage of the whirlpool and dry hop applications, Westbound & Down measured a 0.17pH rise compared to a 0.27pH rise in the 100% T-90 version of this beer.** Yields were also higher due to more efficient wort recovery between whirlpool and fermentation vessels, as well as the lower overall dry-hop load.

Sensory

Westbound & Down's quality control team of four panelists will hedonically rate How The West Was One: Strata® CGX at 2 weeks, 4 weeks, and 8 weeks respectively to compare QC results from the 100% T-90 batch.

Additional Information

Without a similar beer being produced year-round, it will be impossible to conduct QC blind for this study. Both the Strata® T-90 and Strata® CGX hedonic scores will be provided as tested. QC testing will be complete by the week of 5/29/2023.



CASE STUDY 3

Ogopogo Brewing MAMAS LLAMAS

West Coast IPA

To better understand the effects of **CGX® Cryogenic Lupulin Pellets** on beer, **Crosby Hops** collaborated with **Ogopogo Brewing** of San Gabriel, CA on a case study to measure the impact of CGX on finished beer yield.

Identical malt, yeast, and water were used for both batches to eliminate any variabilities other than hops. All other parameters, such as brewing time, temperature, and fermentation conditions, were kept constant.





How does incorporating **CGX® Cryogenic Lupulin Pellets** in a production beer recipe influence finished beer yield compared to a 100% T-90 version of the same recipe?

Hop Varieties Measured



- Estate Grown™ Comet **CGX®**
- Estate Grown™ Comet T-90
- Strata® **CGX®** (an Indie Hops variety)
- Strata® T-90
- Cascade **CGX®**
- Cascade T-90

Background

- **Batch Size:** 15 barrels (x2)
- Two separate 15 barrel batches of beer were brewed using the same brewing equipment and process.
- Identical malt, yeast, and water were used for both batches to eliminate any variabilities other than hops.
- All other parameters, such as brewing time, temperature, and fermentation conditions, were kept constant.



CGX® & T-90 Additions

• T-90 Batch

T-90

Cascade 33lbs

Estate Grown™ Comet 22lbs

Strata® 33lbs

• T-90 + CGX Batch

T-90

Cascade 11lbs

Estate Grown™ Comet 11lbs

Strata® 11lbs

CGX

Cascade 11lbs

Estate Grown™ Comet 11lbs

Strata® 11lbs

Key Discoveries

- T-90 batch yield: 12.7 barrels
- T-90 + CGX batch yield: 13.8 barrels
- Yield increase of 1.1 barrels (+8.7%)

Dollars & Sense

Incorporating CGX into the recipe did increase the raw ingredient cost by \$240 compared to the T-90-only recipe. However, by achieving an 8.7% increase in yield, Ogotogo Brewing was able to generate an additional \$1,800 of revenue per 15-barrel batch. The additional costs and savings net a \$1,560 increase in profitability per batch. Applying this approach to 79 batches per year (roughly half of the production of a 2k bbl brewery that typically yields 84.7%), **a similarly sized and positioned brewery could improve gross profit by \$123k per year.**

	Hop Bill	Yield (15 bbl batch)	Retail Value	Batch Profit
T-90 only	\$960	12.7	\$20,100	
T-90 / CGX	\$1,200	13.8	\$21,900	
Change	-\$240	+1.1	+\$1,800	+\$1,560

Hop costs represent a sampling of spot prices during the spring of 2024. Retail value per barrel is assumed to be \$1,636 based on assumptions regarding local pricing, mix of packaging type, and distribution channel. Results will vary.

In this analysis, hop cost and retail beer pricing are estimates for the purpose of demonstrating potential cost savings of incorporating CGX into a beer recipe.

Conclusion

By replacing T-90 pellets with CGX at a 2x impact pound rate (with the exception of Cascade at 1.5x) in whirlpool, knockout, and dry hop additions, **Ogotogo Brewing was able to increase the yield of finished beer by 1.1 barrels (8.7%).**



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