An alternative for the conservation, storage, and commercialization of small batch Hop productions

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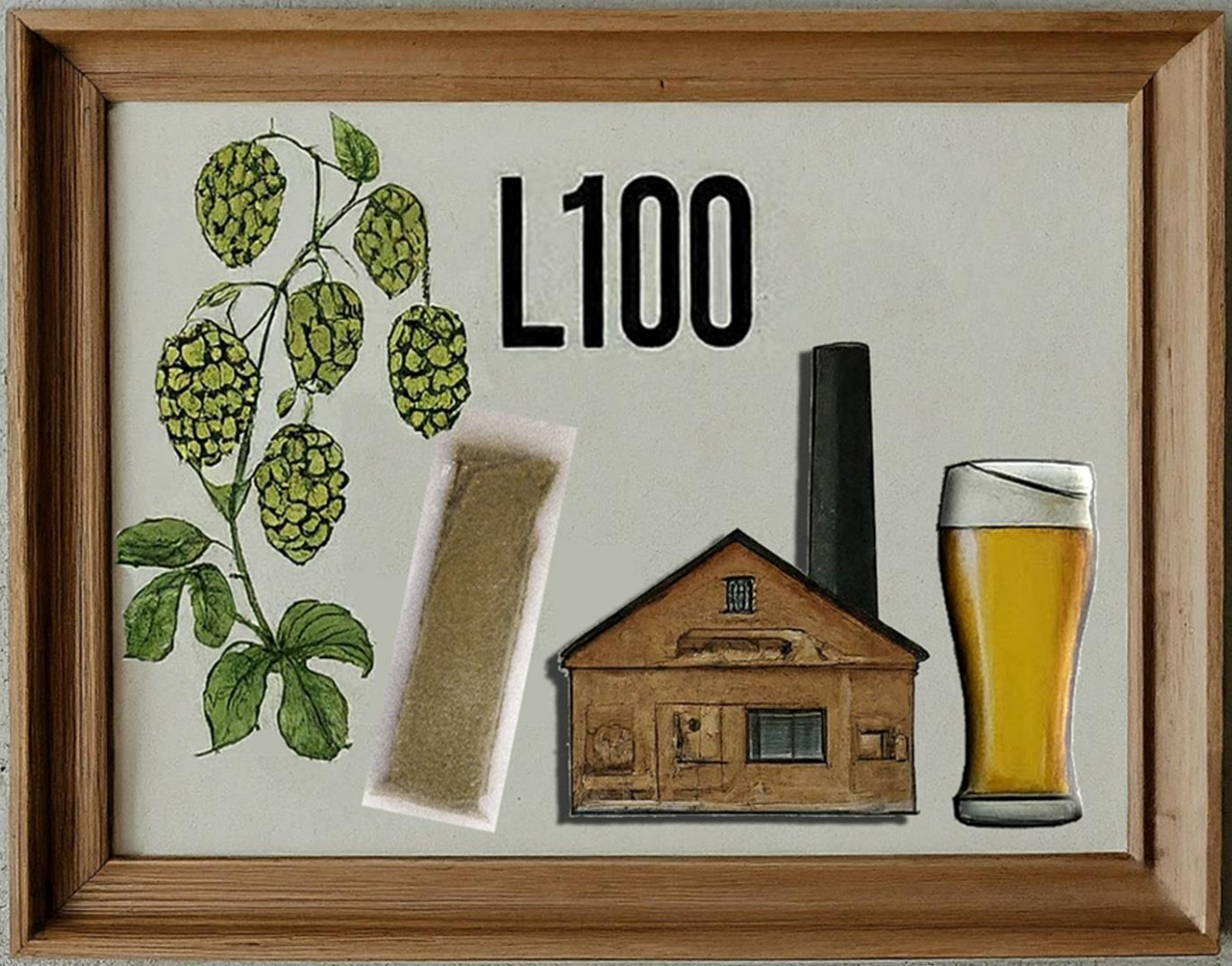

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Series Breves

L100: An alternative for the conservation, storage, and commercialization of small batch Hop productions.

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SUMMARY:

A hop conditioning procedure was developed that allows small producers to market it in an economical and practical way, generating a quality product that can be accepted by craft and industrial breweries. This new commercialization format, which we call L100, consists of ground hops and vacuum packaged in "100-gram ingots" and emerges as an alternative to the T-90 pellet. The L100 format aims to enable small producers to store, conserve and market their productions, increase the supply of hops produced in Argentina and offer a product according to the needs of the beer industry.

INTRODUCTION:

186 billion liters of beer are produced annually worldwide (Barth Hass Report, 2023). Beer has great economic importance since it is ranked third among the most consumed beverages worldwide (after tea and coffee), constituting a mega industry that generates 552 billion dollars per year (Statista., 2023).

Hops (*Humulus lupulus* L.) are a fundamental and irreplaceable input for brewing beer. Its fruits are called "cones" and contain a resinous substance called "lupulin" inside that gives the beer the characteristic aroma, flavor and bitterness. Hops are considered an industrial crop, because the harvested fruits are not used directly (with some exceptions), but must go through conditioning stages (dehydration, grinding, pelletizing and packaging) to obtain the final marketable product. The traditional, standardized and most widespread way of marketing hops prepared as an input for the brewing industry is in the form of a tablet, called T-90 pellet.

Hop cultivation is carried out in numerous countries and different regions of the world. There are approximately 63 thousand hectares cultivated worldwide, with the United States and Germany being the main producing countries (they produce 75% of the world total) (Barth Hass Report, 2023). In Argentina, the total area cultivated with hops is currently around 300 hectares, considering large, medium and small producers. Traditionally, the Patagonian region (Andean Region of the 42nd parallel and the Upper Valley of the Black River) concentrates the largest number of hectares and producers (Nievas et al., 2021).

The annual production of hops in Argentina, on average, manages to supply 20% of the demand of the brewing industry and the missing 80% is hops (T-90 pellet) that must be imported from other countries. In this way, Argentina should reach approximately 2,000 hectares in production to ensure it supplies the hop demand of the national brewing industry. At the same time, the need for hops is regional since neighboring countries such as Brazil, Chile, Uruguay, Paraguay and Bolivia have large brewing industries (Brazil is the third largest beer producer in the world). These countries produce less than 3% of the hops they need, therefore, they are practically 100% supplied with imported hops. On the other hand, the beer industry is constantly expanding due to the development of numerous enterprises (micro breweries and craft breweries), which also generates an increase in the demand for hops.

This context has awakened interest in cultivation, with the aim of increasing Argentine production, expanding the cultivation areas towards environments and regions different from the traditional hop-growing areas. In the last 10 years, hop production tests have been carried out in various locations throughout the country. In several Argentine provinces (Entre Ríos, Córdoba, Santa Fe, Salta, San Luis, Mendoza and Buenos Aires) small hops have been established (generally areas less than 1 hectare) developing cultivation experiences with successful productive results. The crop requires a high initial investment, approximately 15 thousand dollars per hectare (only in trellis structures, installation of drip irrigation and purchase of rhizomes). Therefore, many of the plantations begin with few plants, projecting gradual growth in surface area. Thus, these small hops located in unconventional areas, generally associated with craft breweries, have a very variable size from 30 - 50 to 400 plants. In them, all the tasks required for cultivation, on a small scale, are carried out manually, with some tools that emerge from the resourcefulness of the hop producers.

One of the problems that these new hop producers from non-conventional growing areas encounter is the lack of small machinery that primarily speeds up the tasks of harvesting and conditioning the final product. Furthermore, to achieve the final product prepared in T-90 pellets, a pelletizing machine is needed whose value is around $3,500, constituting an expensive investment for a small producer, which will only be used once a year.

In the search to find an alternative to the way of conditioning hops to be marketed, maintaining similar use characteristics to the T-90 pellet, which is practical, low cost for small producers, and acceptable for the brewing industry, the commercial L100 format was developed.

MATERIALS, METHODS, PROCEDURE AND RESULTS:

The hop cones , harvested by hand, were dried for 48 hours in “rack” type trays (2 m ^{2} wooden frames with half-shade cloth stretched with staples). The trays were stacked (to optimize space) leaving 10 cm of separation between them and were kept in a room with an average ambient temperature of 25º C, in the shade and with a fan to promote air circulation and speed up the drying of the cones **(Fig. 1)**. 800 g of fresh cones were placed per square meter of tray, avoiding overlapping layers of cones. After drying, the cones presented an average of 3% humidity, with small variations depending on the humidity conditions of the environment. The dried cones were placed in cardboard boxes, where they were stored until grinding and packaging. The boxes were kept in a dry, cool and dark environment.

Figure 1. Drying cones: dimensions and arrangement of trays.

The grinding of the dried cones was carried out with a common household appliance blending machine with 500 W of power. The dry cones were placed inside the blender and ground until a homogeneous particle size was observed **(Fig. 2)**. Then, the grinding was transferred from the blender to a glass container to accumulate grinding volume **(Fig. 2)**.

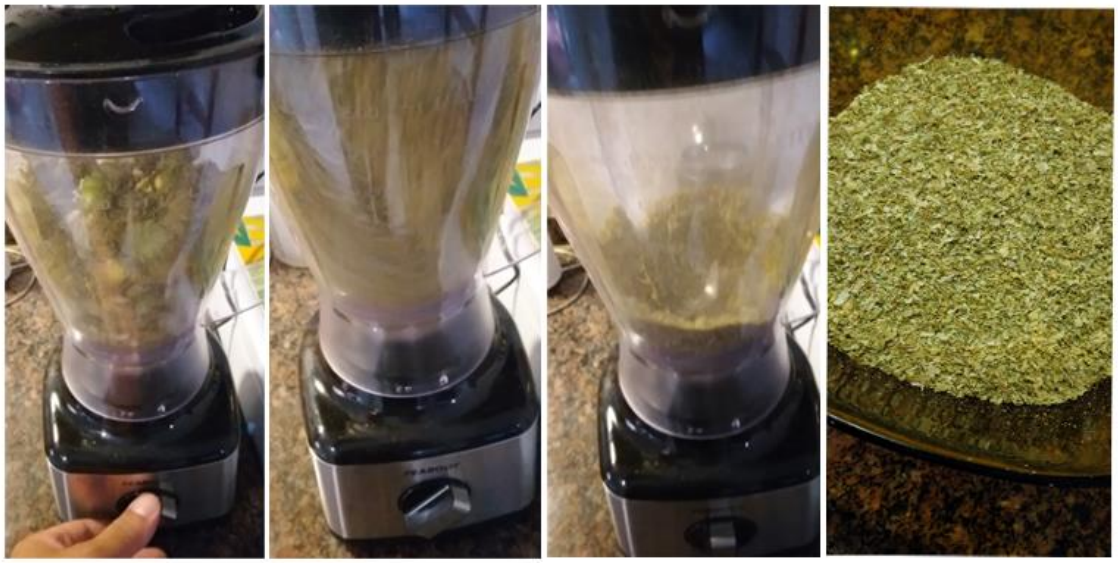

Figure 2. Grinding dry hop cones with a blender.

When packaging, 22 cm wide and 5 m long embossed nylon rolls were used **(Fig. 3)**. Different sizes and shapes of bags were tested (square, cylindrical, rectangular) and finally a rectangular format 35 cm long and 11 cm wide was chosen, with the capacity to store 100 g of product **(Fig. 3)**. This "ingot"-like format allowed the ground hops to be stored quickly, forming a "tablet" of approximately 1.5 cm thick, easy to break when dosing the hops for brewing beer **(Fig. 7)**.

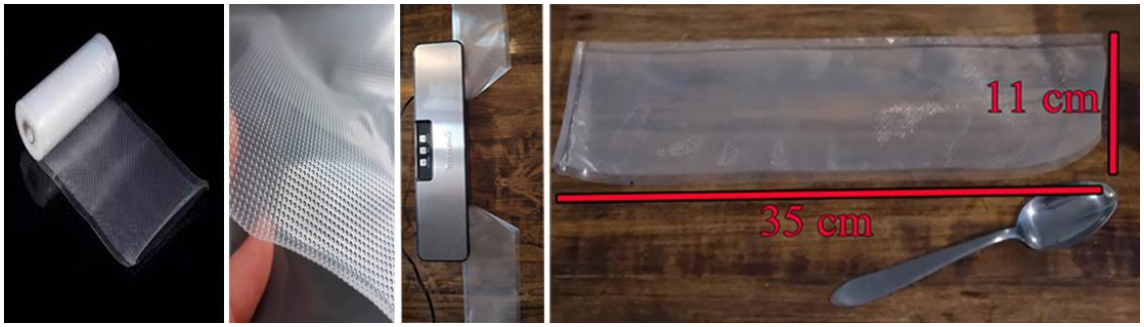

Figure 3. Embossed nylon. Edge sealing and embossed bag dimensions.

Then, the bags were filled using a spoon and a cardboard cylinder to facilitate the beginning of filling **(Fig. 4)**. A kitchen scale was used (calibrating and subtracting the weight of the plastic container = 7 g) to control that the net content of ground hops in each container was 100 g. Therefore, the gross weight was 107 g (package + net content).

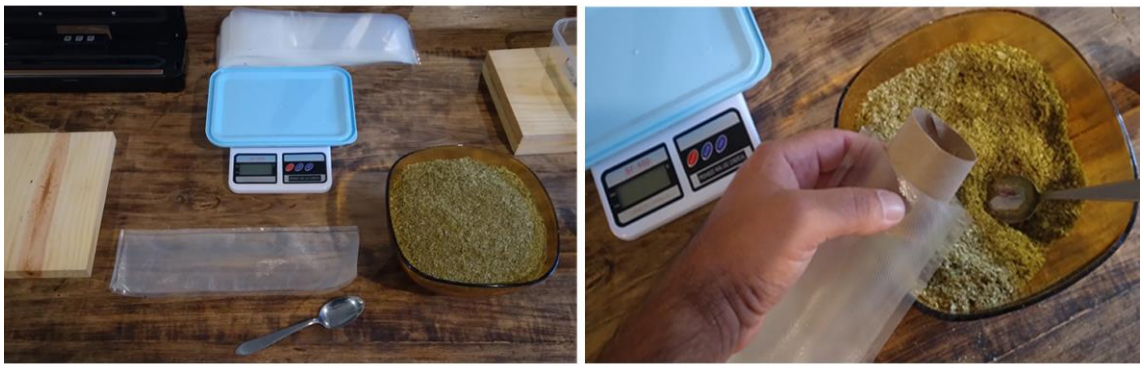

Figure 4. Filling bags.

Once filling was completed, the air was removed and the container was sealed with a model TS-1100 vacuum packaging machine. With the help of wooden boards, the content was arranged to give it uniformity and to flatten the sides of the container **(Fig. 5)**, where a descriptive label was then placed with the following data: varietal name of the hop, net content, content of alpha and beta acids, year of harvest and packaging **(Fig. 5)**. The content of alpha and beta acids was determined at the Institute of Plant Physiology and Genetic Resources of INTA through sample analysis by high performance liquid chromatography (HPLC) **(Fig. 6)**.

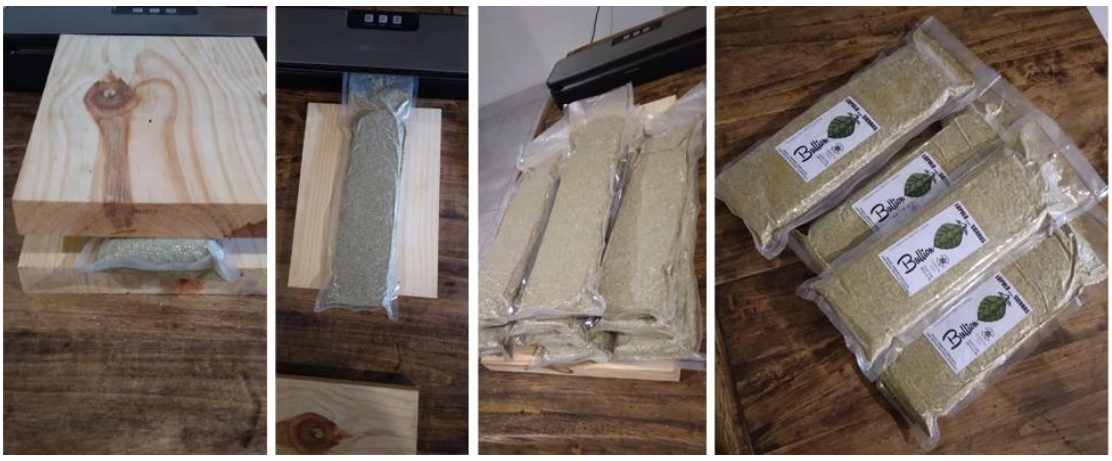

Figure 5. Vacuum packaging and sealing. Labelling. Creation of the L100 commercial format.

Finally, the ingots were stored in a freezer at -20° C **(Fig. 6)**. The average volume of each ingot (L100) was 320 cm ^{3} calculated using the water displacement method (320 ml) (Archimedes' principle). That is, 3125 ingots may be stored in 1 m ^{3} (312.5 kg of hops/m ^{3}). On the other hand, the same measurements were made for 100 g of hops in T-90 pellet format, resulting in 170 cm ^{3} (170 ml of displaced water), which allows storing 5882 100 g packages with T-90 pellets (588.2 kg of hops/m ^{3}). Comparing both formats, the T-90 pellet format shows an advantage in terms of storage since it allows almost double (1.8 times more quantity) of hops to be stored in the same volume of

space, due to the pelleting process whose compression results in higher density. However, the T-90 pellet has an average moisture content of 12%, while the L100 has only 3%. This represents a difference between formats of 9% of the weight, which consists only of stored water.

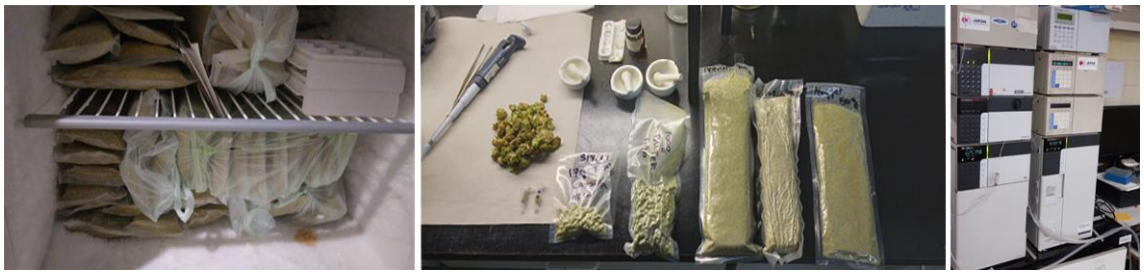

Figure 6. Storage in freezer. Measurement of alpha and beta acid content by HPLC.

Finally, beer was brewed using hops in L100 format **(Fig. 7)**. The ease, agility and practicality in use did not present differences with the use of T-90 pellets. Both formats can be handled without problems for dosing and brewing. The L100 format dissolves without problems during the cooking of the wort, just like the T-90 pellet, and does not generate greater turbidity or clogging of pipes in professional beer brewing equipment. The dosage of L100 hops, depending on the brewing recipe, is 10% less than if the T-90 pellet were used, achieving the same results (adjustment for humidity difference) **(Fig. 7).**

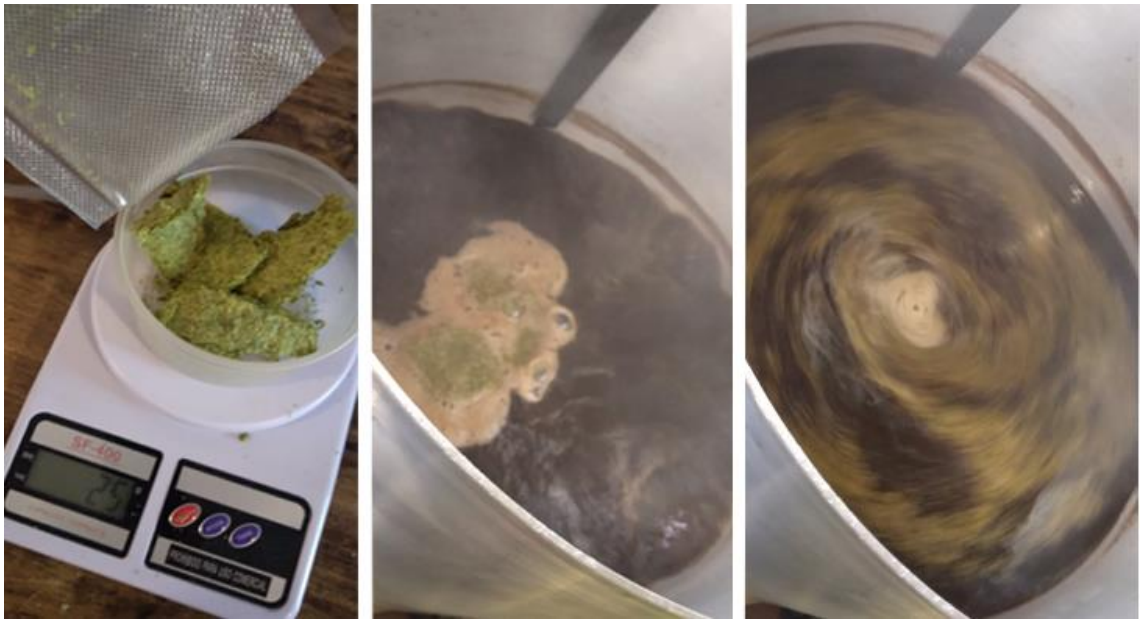

Figure 7. Evaluation of practicality of using hops in L100 format. Dosing and brewing.

When analyzing the conditioning capacity of hops in L100 format, the time it took for a single person to process 1 kg of hops to package it into 10 ingots was 1 hour. This time can be reduced to 30 minutes if the process is carried out with 3 operators:

one person doing the grinding, another person filling each container and the third person vacuuming, sealing, labeling and storing in the freezer. Therefore, the procedure allows us to obtain 16 kg of hops (160 ingots) conditioned for trading in the L100 format in 8 hours of work/day (3 people).

Taking as an example a small hop farm with 210 plants, planted in a "V" pattern, a harvest of 168 kg of fresh cones can be obtained (800 g of fresh cones per plant). After drying, there would be approximately 50 kg of cones that can be converted into 500 L100 ingots in 3 days. Considering an average value of 30 US$/kg of hops, this production can be marketed for a value of 1500 US$. With a conditioning and packaging cost of 200 US$ (4 US$/kg of product).

In conclusion, the L100 format is practical and can favor the growth of small hop producers and increase the supply of this fundamental input for the brewing industry. Even the acceptance and use of the L100 format can supply brewery input warehouses, microbreweries and craft brewing ventures, generating links with small hop producers located nearby. Thus favoring the development and growth of regional economies. In the future, tests, evaluations and comparisons will be carried out that provide more information about the L100 format.

The main objective of this work is to present the development of the L100 format to market hops, and disseminate its use among small-scale producers, providing a practical and low-cost packaging and marketing alternative. It should be noted that for large producers the T-90 pellet format will continue to be the optimal way of conditioning, storing and marketing hops.

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