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## Anaphylaxis Induced by Beer

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The prevalence of cereal allergy is highly influenced by geographical area and consumption habits. According to data from Alergologica 2015 [1], cereal allergy accounts for 2.1% of all cases of food allergy in Spain.

Beer is a barley-based alcoholic beverage that also contains hops, yeast, and other cereals (wheat, oats, corn, and even rye). Barley is also the basis of malt vinegar, whiskey, and gin. Several allergens of barley have been described, including lipid transfer protein (LTP),  $\alpha$ - and  $\beta$ -amylase, gliadin, glutenin, peroxiredoxin, thionin, and trypsin inhibitor [2].

We present a case of beer-induced anaphylaxis. A 48-year-old man with no personal history of allergy experienced sudden loss of consciousness after drinking beer.

Five to six years previously, he had experienced pharyngeal pruritus and mild dyspnea with no other systemic symptoms after drinking beer, which he subsequently avoided for several years. After trying it again, he immediately lost consciousness and experienced a mandibular fracture. The physical examination at the time of the consultation was normal.

All ingredients except barley were tolerated afterwards.

Skin prick testing (SPT) with a standard panel of aeroallergen extracts was positive only to mugwort. The results of SPT with food extracts were negative. SPT with commercial cereal extracts (corn, wheat, rice, oat, barley, rye, gluten, and gliadin [LETI]) was negative, with a mild response to barley (histamine,  $<2 \times 2$  mm). Prick by prick testing with beer (San Miguel) was positive ( $5 \times 7$  mm). Total IgE and basal tryptase values (ImmunoCAP, Thermo Fisher Scientific) were 160 kU/L and 3.84  $\mu\text{g/L}$  respectively, and specific IgE antibodies were as follows: wheat (*Triticum aestivum*), 0.03 kU<sub>A</sub>/L; barley (*Avena sativa*),  $<0.1$  kU<sub>A</sub>/L; hop (*Humulus lupulus*),  $<0.1$  kU<sub>A</sub>/L; rPru p 3,  $<0.1$  kU<sub>A</sub>/L; and  $\omega$ -5 gliadin, 0 kU<sub>A</sub>/L. ImmunoCAP ISAC microarray (Thermo Fisher Scientific) revealed a positive result only for nArt v 1 (0.6 ISU).

Protein extract from hop, rice, barley, rye, corn, wheat, and beer yeast were homogenized in phosphate-buffered saline,

dialyzed, concentrated, and stabilized by lyophilization. Sodium dodecyl sulphate–polyacrylamide gel electrophoresis (SDS-PAGE) was carried out under reducing conditions as described by Laemmli [3] with 7 different beer brands, hop, rice, barley, rye, corn, wheat, and beer yeast extracts in patient sera. Western blot revealed an IgE-binding band of 10–12 kDa in the extract of all the beers (independently of the gluten content) and barley (Figure), which was extracted from the gel, digested with trypsin, and analyzed using mass spectrometry (HR, ORBITRAP, short gradient), as previously described [4]. Three peptides from LTP1 (Hor v 7k-LTP) with 15% coverage were identified.

LTP1 results from a modification of posttranslational LTP by a bond between aspic acid and ester linkages. Low amounts of LTP1 are present in barley kernel. LTP1 is highly stable during malting and brewing and is unaffected by boiling and proteolysis; therefore, it can be found intact in beer, where it is a major protein component [5].

Reactivity of IgE to Hor v 7k-LTP is often associated with severe systemic symptoms, although unlike Hor v 14, which

is a classic LTP of barley and LTP1, it does not cross-react with other LTPs [5].

Several studies identified a 10-kDa allergenic protein by Western blot in beer-allergic patients, suggesting that the culprit allergen could be the classic LTP of barley (Hor v 14) [6–10]. In most case reports, patients did not tolerate other fruits and nuts, thus suggesting cross-reactivity with other LTPs [6–8].

Tolerance of other foods, negative skin prick test results to foods, and negative serum specific IgE results for other LTPs point to Hor v 7k-LTP as the causative allergen in this case.

In conclusion, our study of a case of anaphylaxis after ingestion of beer revealed the possible culprit allergen to be the LTP Hor v 7k. To date, this is the first report of an LTP1 of barley as the causative allergen in beer allergy. Our findings have implications for dietary recommendations in the case we report, namely, that the patient should avoid barley and manufactured products that contain barley.

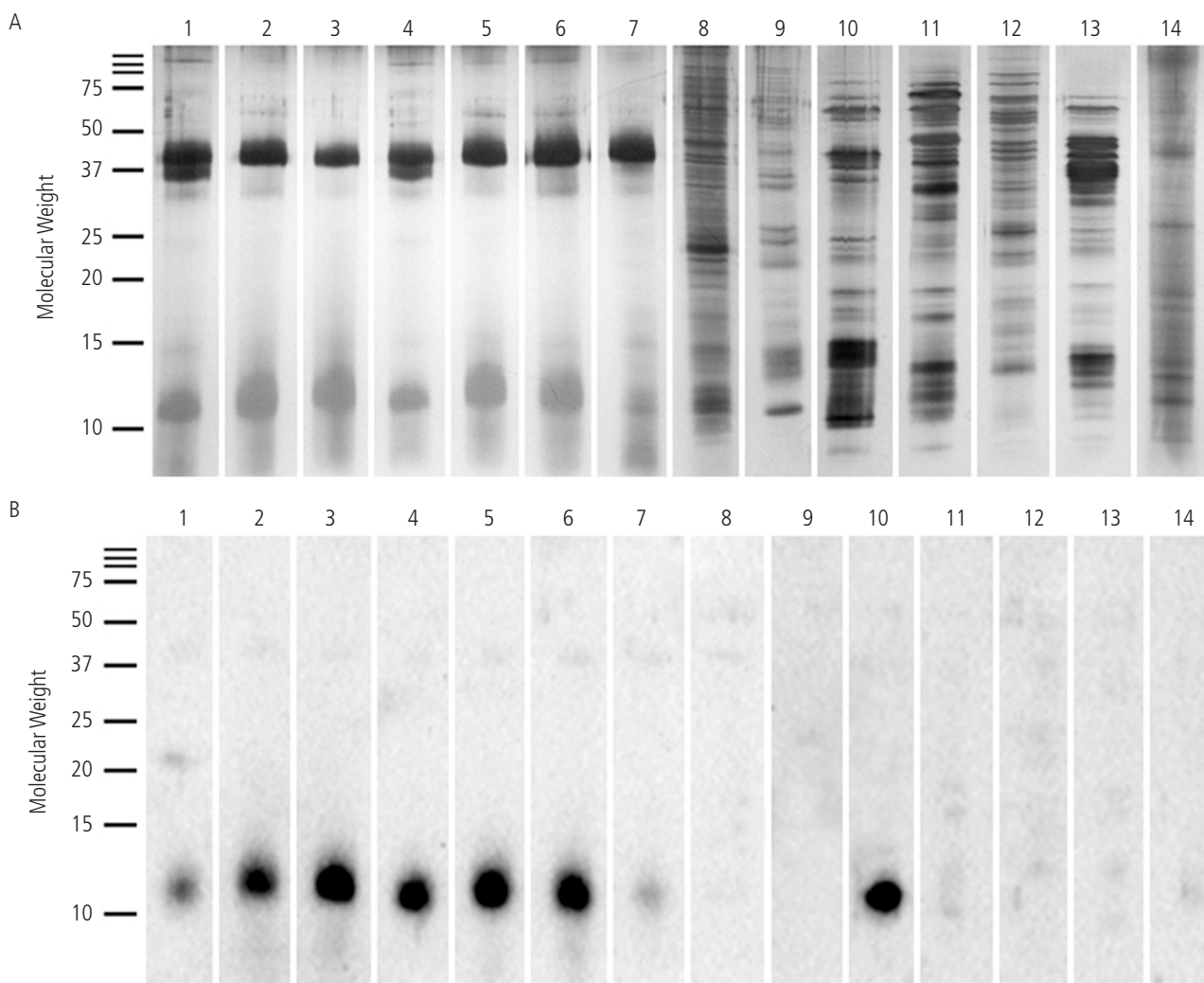


Figure. A, SDS-PAGE. B, Western blot. Lane 1, San Miguel gluten-free beer; lane 2, San Miguel beer; lane 3, San Miguel alcohol-free beer; lane 4, Mahou gluten-free beer; lane 5, Mahou beer; lane 6, Mahou double-hop beer; lane 7, Dutch beer (Carrefour); lane 8, hop; lane 9, rice; lane 10, barley; lane 11, rye; lane 12, corn; lane 13, wheat; lane 14, beer yeast.

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### *Conflicts of Interest*

Dr Roger reports personal fees from Diater outside the submitted work. The remaining authors declare that they have no conflicts of interest.

### *Previous Presentation*

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