# THE ANTIBACTERIAL ACTIVITY OF HOP COMPOUNDS

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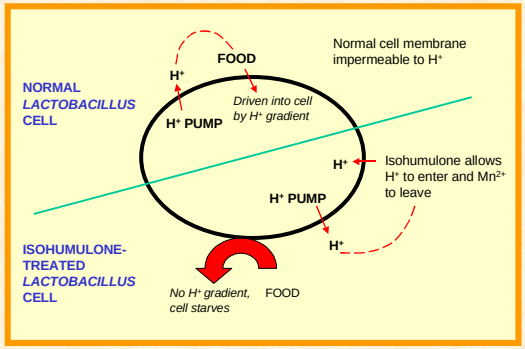


**FIGURE 1. EFFECT OF ISO-ALPHA-ACIDS ON CELL MEMBRANES.**

## METHODS

- iso-α-acids added to modified MRS broth, pH range 3.6 – 6.4
- inoculated with beer spoilage *Lactobacillus brevis*
- incubation (in dark) at 25°C for 48 hours
- Minimum Inhibitory Concentration (MIC) of each compound determined by measuring absorbance at 560 nm
- hydrophobicity determined using reverse-phase HPLC (*Hughes* et al, 1996)

The antibacterial activities of 12 iso-α-acids were investigated:

- *cis*- & *trans*- isomers of 3 naturally occurring iso-α-acids
- 5 chemically reduced iso-α-acids
- reduced iso-α-acid mixture

i.e.

| | |
|---|---|
| **TIC** | *trans*-isocohumulone |
| **CIC** | *cis*-isocohumulone |
| **TIH** | *trans*-isohumulone |
| **TIA** | *trans*-isoadhumulone |
| **CIH** | *cis*-isohumulone |
| **CIA** | *cis*-isoadhumulone |
| **RIH** | reduced iso-α-acids |
| **DH1** | dihydroiso-α-acid 1 |
| **DH2** | dihydroiso-α-acid 2 |
| **TTIC** | *trans*-tetrahydroisocohumulone |
| **HIC** | hexahydroisocohumulone |
| **HIH** | hexahydroisohumulone |

## INTRODUCTION

Hops are used to impart bitterness and aromatic flavours to beer, however certain compounds also possess antimicrobial properties. The iso-α-acids in particular possess strong antibacterial action against Gram positive bacteria (*Simpson & Smith*, 1992).

Iso-α-acids act as mobile carrier type ionophores, causing breakdown of the trans-membrane proton gradient of susceptible cells (*Simpson*, 1993). The cell is therefore unable to take up nutrients (Figure 1).

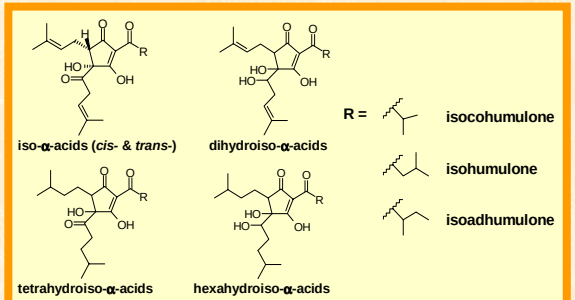


**FIGURE 2. ISO-ALPHA-ACIDS STUDIED**

Increased hydrophobicity leads to a greater antimicrobial activity (Figure 3). The more hydrophobic, reduced iso-α-acids are more antimicrobial than their naturally occurring analogues, and the degree of reduction is important (Figure 4). Increased hydrophobicity results in increased lipophilicity. This would render a compound more prone to interaction with the cell membrane, which could explain the observed effects.

References

Hughes, P.S., Wilde, P.J. & Meneer, I.D., *Eur. Brew. Conv. Beer Foam Sub-Group Meeting*, 1996, 74-91

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Simpson, W.J. & Smith, A.R.W., *J. Appl. Bacteriol.*, 1992, **72**, 327-334

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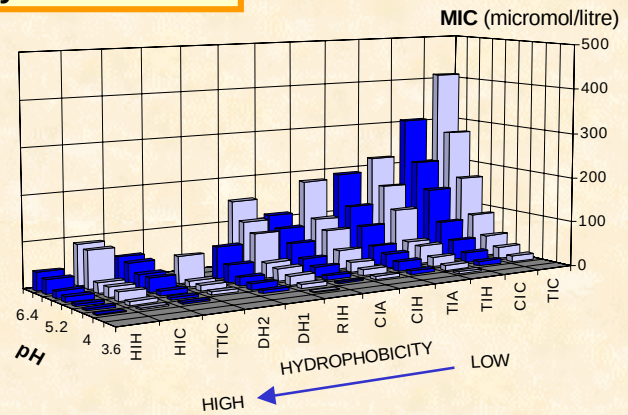


**FIGURE 3. EFFECT OF pH AND HYDROPHOBICITY ON ANTIMICROBIAL ACTIVITY**

(n.b. the lower the MIC value, the higher the antimicrobial activity)

Figure 3 also shows that antimicrobial activity is higher at lower pH (first noted by Shimwell, 1937). It is the undissociated forms of the iso-α-acids that possess antimicrobial properties. As they are weakly acidic, at lower pH there will be a greater concentration of the undissociated iso-α-acids.

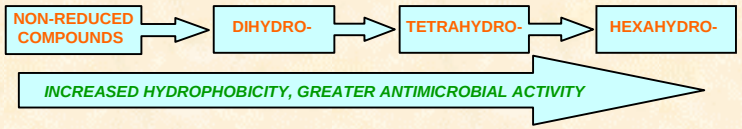


**FIGURE 4. DEGREE OF HYDROPHOBICITY OF HOP COMPOUNDS.**

## CONCLUSIONS

- reduced hydrophobicity & lower pH ↑ increased antimicrobial activity.
- chemically reduced iso-α-acids ↑ more antimicrobial.
- reduced hop compounds often used to prevent 'lightstruck' flavour.
- for sterile filtered, unpasteurised beers that are prone to microbiological problems, the addition of reduced hop compounds ↑ additional benefit of improved microbiological stability.

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Sheila Lee for technical assistance, Louise Bolshaw for purification of hop compounds and Paul Hughes for hydrophobicity data