CHAPTER IV

THE ADSORPTION OF HOP SUBSTANCES ON THE YEAST CELL WALL

Spent yeast has a strong bitter flavor which limits its use both in human food products and in animal feeds (Menegazzi, 1980). Bitterness of spent brewer's yeast is attributable to hop constituents, chiefly resins and tannins, adsorbed on the yeast cell wall (Dixon, 1968).

Yeast cells remove hop substances from wort during fermentation. The hop substances are regarded as being bound to the yeast by adsorptive forces, the strength of which is such that compounds can be removed by dilute sodium carbonate solution or by urea, thiourea and potassium thiocyanate solutions, reagents usually employed to eliminate hydrogen bonds and other weak forces (Dixon, 1968).

During fermentation, hop substances in the wort were removed. The losses were influenced by the hop rate, the period of wort boiling and both the specific gravity and the pH of the wort. The humulone disappeared during fermentation had been recovered by yeast or undergone some chemical changes. The bulk of the hop substances lost during fermentation was carried to the surface of the fermenting liquid by bubbles of carbon dioxide gas and tended to concentrate in the uppermost layer. For top fermentation yeast strains, hop substances became admixed with the yeast in the yeast head.

The adsorption of hop compounds to the yeast followed the pattern of the Freundlich adsorption isotherm (Figure 4-1).

Then, $$\log \frac{X}{m} = \log K + \frac{1}{n} \log C \qquad \text{.....4.1}$$

X is the quantity of bitter substances attached to the yeast

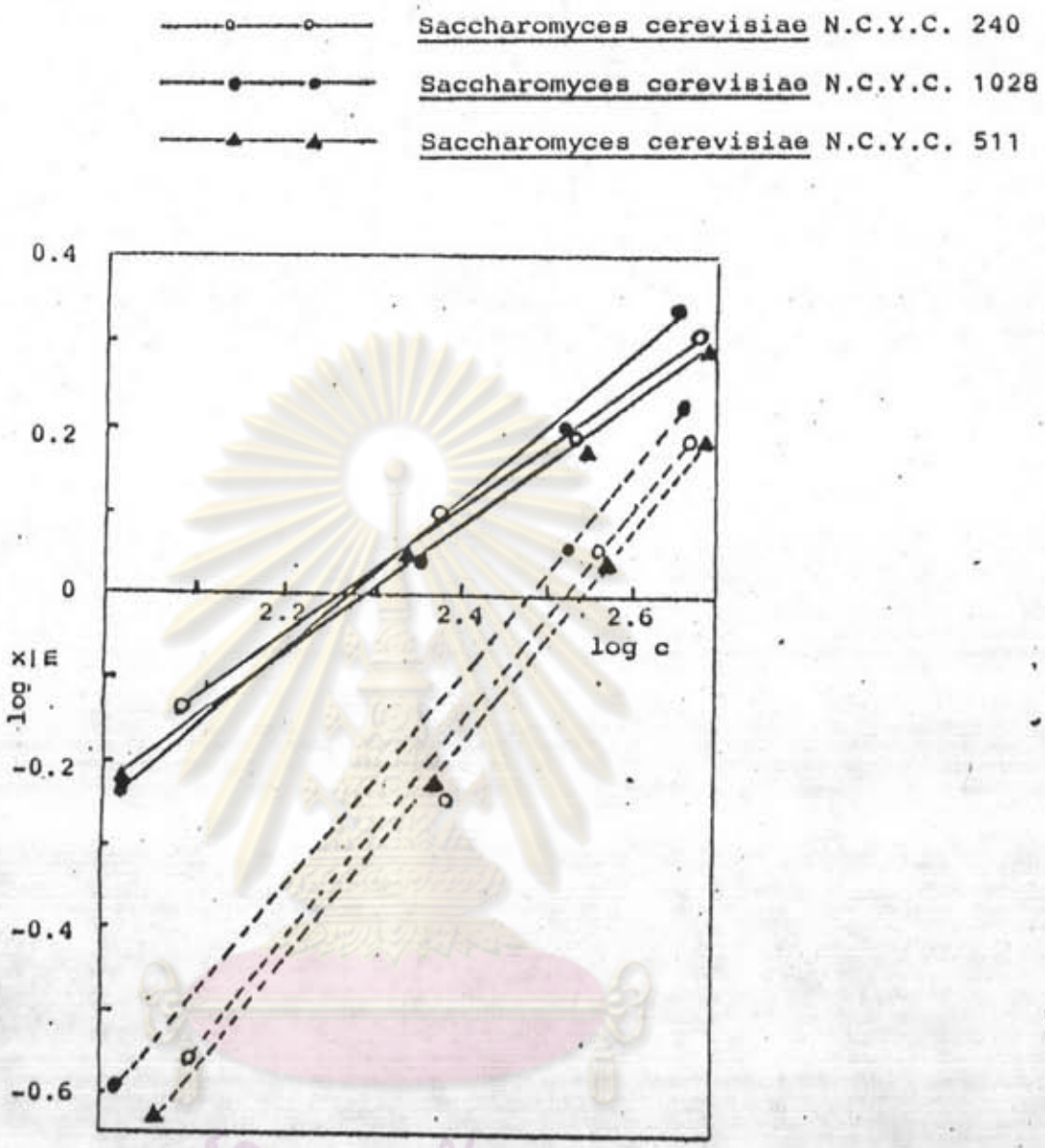

Figure 4-1 Plot of the logarithm of hop substances adsorbed per unit mass of yeast against the logarithm of the final concentration of hop substances in the beer. Broken lines refer to fermentations carried out on the same series of worts at the same time. The unbroken lines refer to a different series of fermentations carried out in a similar manner (Dixon, 1968)

m is the weight of yeast after fermentation.

C is the concentration of bitter substances in the beer at equilibrium of adsorption.

K, n are constant.

The "n" of the equation of the Freundlich adsorption isotherm is a constant for any one set of conditions. Each value showed in table 4-1 was only constant for a series of worts of similar composition pitched at the same time. When a different series of worts was employed with the same yeast, linearity was maintained, but a different value of "n" was obtained. Similarly, identical values of "n" were obtained when three different yeasts were pitched into the same series of worts (Table 4-1, Figure 4-1) and when the wort was changed, the values of "n" for the three yeasts changed by approximately the same amount (Dixon, 1968).

Table 4-1 Values of $\frac{1}{n}$ and n in the equation of the Freundlich adsorption isotherm for hop substances on yeast cells (Dixon, 1968)

Fermentation number	Yeast*	$\frac{1}{n}$	n
1	240	1.25	0.80
2	240	1.78	0.56
3	240	0.98	1.02
4	240	1.67	0.60
5	240	1.78	0.56
6	240	0.58	1.73
7	1028	0.78	1.28
7	240	0.81	1.24
7	511	0.92	1.09
8	1028	1.34	0.75
8	240	1.35	0.74
8	511	1.29	0.78

* 240 for Saccharomyces cerevisiae (N.C.Y.C. 240).
1028 for Saccharomyces cerevisiae (N.C.Y.C. 1028).
511 for Saccharomyces carlsbergensis (N.C.Y.C. 511).