Curso Profesional en Agua Cervecera (Clase 5)

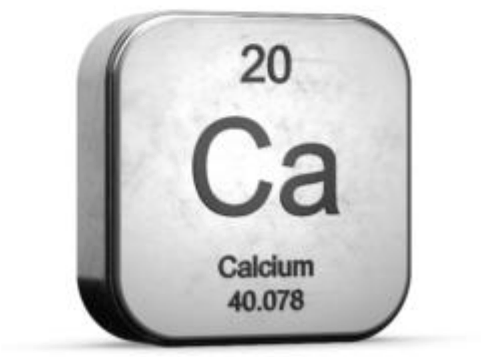
Lic. Sebastián Oddone

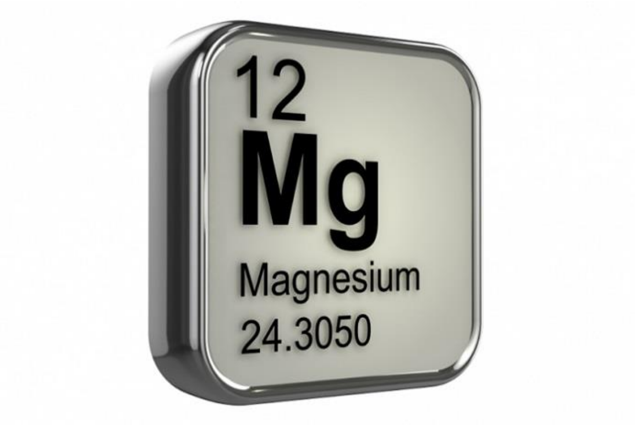
ESPECIALISTA EN FERMENTACIONES INDUSTRIALES

Importancia del Calcio y Magnesio

Calcio (2+): ayuda a disminuir el pH, estabiliza a la alfa-amilasa, ayuda a flocular levaduras y coágulos. (máx. 250ppm)

Magnesio (2+): esenciales para el funcionamiento de algunas enzimas (máx. 50ppm)





Importancia del Calcio y Magnesio

The effects of increased magnesium and calcium concentrations on yeast fermentation performance in high gravity worts

E. M R Rees, Graham G. Stewart

Journal of the Institute of Brewing

Published - Sep 1997

Abstract

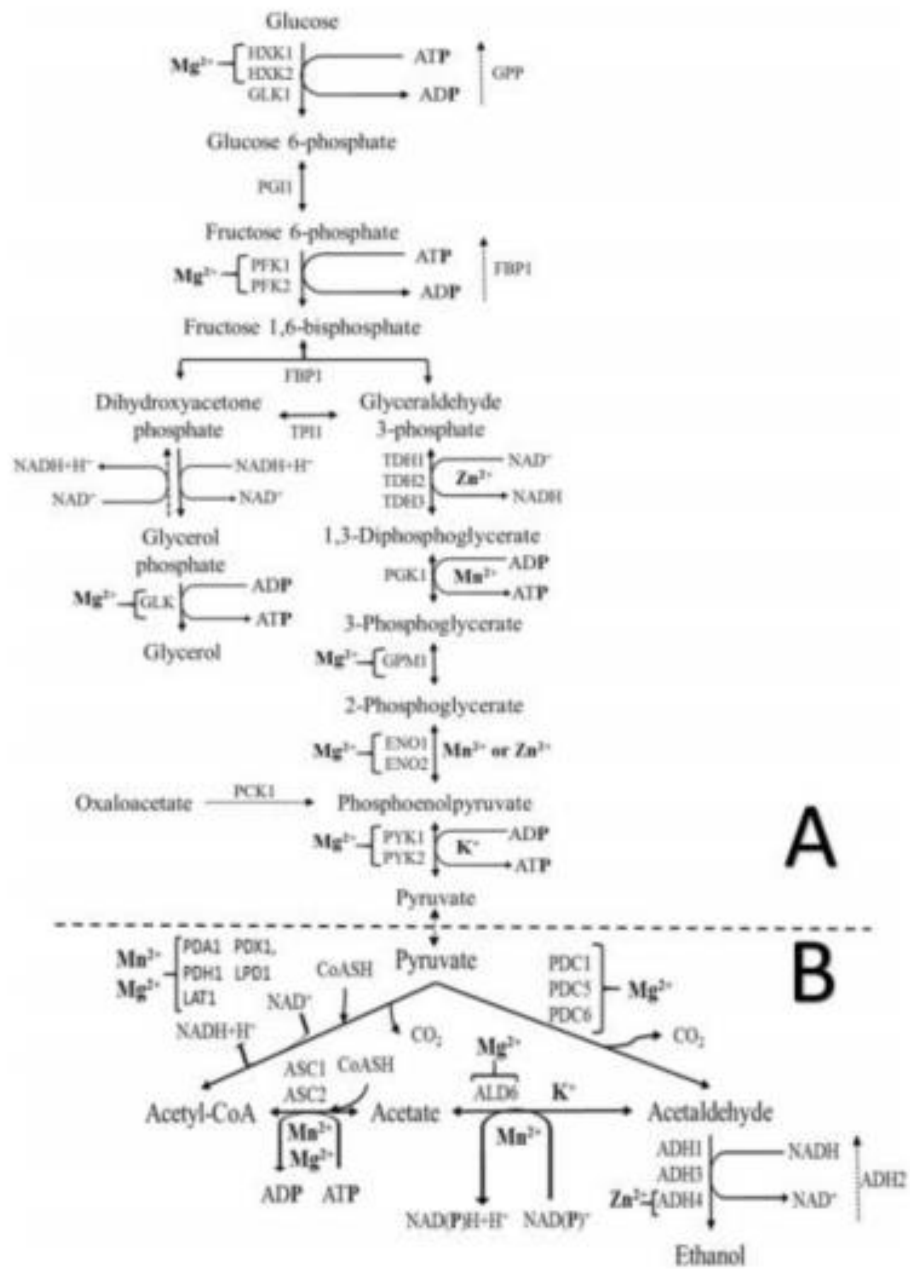
The response of a number of Saccharomyces cerevisiae (ale) and Saccharomyces uvarum (carlsbergensis) (lager) strains to altered starting levels of magnesium and calcium in 12°P (1048 original gravity) or 20°P (1080 original gravity) wort were investigated. In general, the same trends were observed in all 6 strains, however the extent of the response to adjusted levels of magnesium and calcium were found to be strain dependent. The results indicate that an increased ratio of magnesium to calcium causes an increase in the initial fermentation rate, the rate and yield of ethanol produced and an increase in vitality at the end of fermentation, in all strains employed. Upon increasing the calcium to magnesium ratio it was found that the initial fermentation rate was decreased, resulting in an increased attenuation time in the case of the lager strains. It was also noted that increasing the calcium to magnesium ratio led to a decreased ethanol production, maltotriose uptake, and in the case of the lager strains, maltose uptake was also adversely affected under these conditions. Altering the calcium and magnesium levels had no effect on the viability of the yeast or on glycogen levels.

Importancia del Calcio y Magnesio

Influence of Magnesium and Calcium Variability on Yeast Fermentation Performance[24]

YEAST STRAIN	MEDIUM	MAGNESIUM (MG/L)	CALCIUM (MG/L)	MAGNESIUM TO CALCIUM	FINAL ETHANOL (%, V/V)	DIFFERENCE
Saccharomyces cerevisiae DBV 2168	White wine must	67	136	0.5	7.1	0 (control)
		1,217	114	10.7	8.7	+1.6
		47	768	0.06	4.8	-2.3
S. cerevisiae DCLM	Cane molasses	100	450	0.22	5.6	0 (control)
		190	450	0.42	6.8	+1.2
S. cerevisiae NCYC 1109	Malt wort (OG 1062)	225	140	1.6	6.0	0 (control)
		257	710	0.36	5.8	-0.2
		265	1,675	0.16	5.7	-0.3
		280	2,100	0.13	4.8	-1.2
S. cerevisiae DCLM		1,500	10,000	0.15	5.7	0 (control)
		1,500	1,000	1.5	7.7	+2.0

Importancia del Calcio y Magnesio



Importancia del Calcio y Magnesio

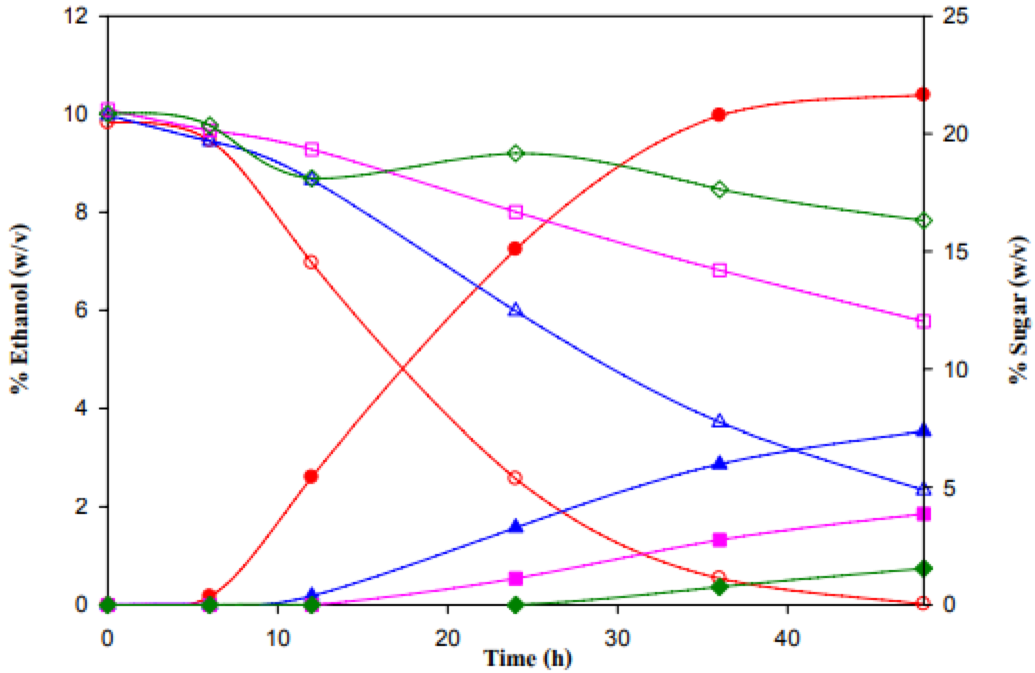


Fig. 1—Changes of ethanol and sucrose concentrations during fermentation of sucrose (20% w/v) having different calcium concentrations (0–2.16% w/v of Ca^{2+}) by *Saccharomyces cerevisiae*. (Open symbols represent sugar contents and filled symbols represent ethanol content at different calcium concentrations; ○,● 0%; Δ, ▲ 0.72%; □, ■ 1.44% and ◊, ♦2.16% Ca^{2+}).

Chotineeranat, S. *et al.* **Proc. Int. Soc. Sugar Cane Technol., Vol. 27, 2010**

Aporte de minerales de las maltas

Effect of Malting on Chemical Composition, Minerals Content and Microbiological Quality in Different Varieties of Barley (*Hordeum vulgare*)

Saeed Abdullah Badahdah [*1], **Baraka Mohamed Kabeir Baraka**[1] **and Salma Elghali Mustafa**[1]

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[*]Corresponding author: Email saeed_seef@hotmail.com
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Table 3: Mineral content (mg/100g) of non-malted and malted barley

Minerals	Treatment	Varieties		
		A	B	C
Ca	Non-malted	$27.17\pm1.37_{a}^{a}$	$212.11\pm4.88^{b}_{a}$	$24.35\pm1.38^{a}_{a}$
	Malted	$26.66\pm 0.54_{a}^{a}$	$207.95\pm5.88^{b}_{a}$	$22.52\pm0.20^{a}_{b}$
K	Non-malted	$298.67\pm0.81^{a}_{a}$	$266.68\pm1.17^{b}_{a}$	$252.67 \pm4.02^{c}_{a}$
	Malted	$277.27\pm5.54^{a}_{b}$	$249.82\pm9.86^{b}_{b}$	$220.11\pm0.60^{c}_{b}$
P	Non-malted	$228\pm5.75^{a}_{a}$	$231.6\pm1.10^{a}_{a}$	$209.81\pm0.95^{b}_{a}$
	Malted	$210.99\pm1.21^{a}_{b}$	$228.15\pm5.07^{b}_{a}$	$213.66\pm2.31^{a}_{a}$
Na	Non-malted	$9.60\pm0.63^{a}_{a}$	$6.56\pm0.26^{b}_{a}$	$8.19\pm0.63^{c}_{a}$
	Malted	$6.56\pm0.25^{a}_{b}$	$5.38\pm0.095^{b}_{b}$	$6.56\pm0.26^{a}_{b}$
Cu	Non-malted	$0.95\pm 0.29^{a}_{a}$	$0.54\pm0.03^{b}_{a}$	$0.68\pm0.02^{c}_{a}$
	Malted	$0.73\pm0.05^{a}_{b}$	$0.49\pm0.011^{b}_{a}$	$0.51\pm0.1^{b}_{b}$
Fe	Non-malted	$2.54\pm 0.020^{a}_{a}$	$1.93\pm0.68^{b}_{a}$	$2.12\pm0.01^{b}_{a}$
	Malted	$1.96\pm0.15^{a}_{b}$	$1.55\pm0.12^{a}_{b}$	$2.04\pm0.03^{a}_{b}$
Mg	Non-malted	$64.27 \pm2.31^{a}_{a}$	$52.64\pm0.39^{b}_{a}$	$68.53\pm0.92^{c}_{a}$
	Malted	$60.53\pm0.68^{a}_{a}$	$51.37\pm0.95^{b}_{a}$	$60.87\pm0.77^{a}_{b}$
Mn	Non-malted	$1.29\pm 0.02^{a}_{a}$	$1.15\pm 0.05^{b}_{a}$	$1.23\pm0.06^{a}_{a}$
	Malted	$1.08\pm0.01^{a}_{b}$	$1.02\pm0.051^{b}_{b}$	$1.02\pm0.01^{b}_{b}$
Zn	Non-malted	$1.65\pm 0.13^{a}_{a}$	$1.49\pm0.12^{a}_{a}$	$1.77\pm0.26^{a}_{a}$
	Malted	$1.48\pm0.30^{a}_{a}$	$1.55\pm0.18^{a}_{a}$	$1.31\pm0.1^{a}_{b}$

Aporte de minerales en insumos

J. Inst. Brew., January–February, 1977, Vol. 83, *pp.* 15–16

DETERMINATION OF METALS IN BREWING MATERIALS BY FLAMELESS ATOMIC ABSORPTION SPECTROSCOPY

By T. R. M. Helin* and J. C. Slaughter
(*Department of Brewing and Biological Sciences, Heriot-Watt University, Chambers Street, Edinburgh,*

TABLE III. Metals through the brewing process.

Metal*	Malt	Hops	Wort SG 1040	Beer OG 1040
Mg	1018	2205	69·6	60·0
Ca	544	10270	7·5	10·0
Al	24·6	192	0·42	0·26
Fe	51·8	361	0·10	0·08
Mn	13·3	82·1	0·15	0·12
Zn	16·4	47·6	0·118	0·036
Cu	4·6	16·9	0·054	0·015
Ni	0·49	2·9	0·02	0·015
Pb	0·20	1·2	0·02	0·02
Co	0·14	<0·05	0·01	<0·002

* Concentrations are given as mg/kg dry weight of malt and hops, and as mg/l wort and beer.

80 g of malt and 1 g hops were used to produce 500 ml of beer (OG 1040) using the technique described in the Methods section. Conditions for metal analyses are given in Tables I and II

Table 34.3 Minerals in malt (mg/kg dry matter)

Minerals	*Reference 1*[a]	*Reference 2*[b]	*Reference 3*[c]
K^+		3,530	3,618
PO_4^{3-}	6,329		
Mg^{2+}	1,155	1,370	1,421
Ca^{2+}	479	730	824
Na^+		28.2	25.0
Cl^-	830		
SO_4^{2-}	300		
SiO_2	5,260		

Notes: The quantity of different minerals in malt from different authors.

[a] Kolbach and Rinke (1963).
[b] Holzmann (1975).
[c] Mändl *et al.* (1972).

Table 3. Content of metal ions in hops (mg/kg original weight)

Ion	Bitter hops	Aroma hops
Mg^{2+}	1846 ± 44 a[a]	2393 ± 54 b
Mn^{2+}	60.5 ± 1.2 a	70.5 ± 2.1 b
Zn^{2+}	41.1 ± 1.0 a	36.8 ± 0.9 b
Fe	20.0 ± 0.6 a	21.0 ± 1.1 a

[a] Values are means ± SD ($n = 4$); letters within the same ion indicate homogenous groups.

Aporte de minerales en trigo malteado

Received: 2 October 2014 Revised: 28 November 2014 Accepted: 23 February 2015 Published online in Wiley Online Library: 30 March 2015

(wileyonlinelibrary.com) DOI 10.1002/jib.226

Effect of wheat malt on the concentration of metal ions in wort and brewhouse by-products

Aleksander Poreda,[1]* Monika Bijak,[1] Marek Zdaniewicz,[1] Marek Jakubowski[2] and Małgorzata Makarewicz[1]

Table 2. Content of metal ions in wheat malt and barley malt grains (mg/kg original weight)

Ion	Wheat malt	Barley malt
Mg^{2+}	1387.5 ± 28 a[a]	1360.2 ± 206 a
Mn^{2+}	27.6 ± 1.0 a	10.9 ± 0.5 b
Zn^{2+}	28.3 ± 1.7 a	24.9 ± 1.3 b
Fe	16.0 ± 0.9 a	13.4 ± 0.8 b

[a]Values are means ± SD ($n = 4$); letters within the same ion indicate homogenous groups.

Table 5. Content of the metal ions in hot trub collected after wort boiling (mg/kg dry weight)

Hot trub	Ion concentration in hot trub			
	Mg^{2+}	Mn^{2+}	Zn^{2+}	Fe
$WM_{0\%}$	2813 ± 247 a[a]	29.6 ± 5.0 a	53.3 ± 3.7 a	28.2 ± 2.2 a
$WM_{20\%}$	2994 ± 206 a	38.1 ± 2.5 b	66.3 ± 4.1 b	28.7 ± 0.7 a
$WM_{40\%}$	2901 ± 100 a	42.9 ± 5.0 b	55.8 ± 9.2 a	29.3 ± 4.5 a
$WM_{60\%}$	3115 ± 338 a	54.3 ± 3.2 c	57.1 ± 8.2 ab	44.3 ± 4.2 b

[a]Values are means ± SD ($n = 4$); letters within the same ion indicate homogenous groups.

Aporte de magnesio en otros granos y adjuntos

Table 2. Concentration of Mg determined by FAAS in brewing grains.

Ingredient[a]	Magnesium (mg/L)			
Barley				
Pale Malted Barley	27.7	±	0.0017	(1.10)
Organic Malted Barley (A)	4.8	±	0.0012	(2.14)
Flaked Barley (B)	51.2	±	0.0012	(0.44)
Toasted Barley Flakes (A)	76.8	±	0.0021	(0.55)
Toasted Barley Whole	31.7	±	0.0017	(0.98)
Dark Munich Malt	99.6	±	0.0012	(0.24)
Chocolate Malt	42.1	±	0.0006	(0.26)
Adjunct				
Malted Wheat (B)	111.5	±	0.0007	(0.13)
Malted Rye	109.3	±	0.0026	(0.50)
Flaked Oats	16.5	±	0.0017	(1.62)
Flaked Oats (B)	87.2	±	0.0062	(1.46)
Flaked Rice (C)	8.5	±	0.0017	(2.44)
Flaked Wheat (B)	53.2	±	0.0021	(0.76)
Flaked Corn (B)	87.6	±	0.0040	(0.94)
Flaked Rye (C)	79.9	±	0.0036	(0.92)

[a]Corresponding letters indicate ingredients obtained from same suppliers.

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Minerals in Beer

Luigi Montanari, Heidi Mayer, Ombretta Marconi and Paolo Fantozzi Italian Brewing Research Centre (CERB), University of Perugia, Via San Costanzo, Perugia, Italy

Table 34.4 Minerals in adjuncts

Minerals	*Maize grits (mg/kg)*	*Rice (mg/kg)*
Ca^{2+}	24 ± 8	460 ± 26
K^{+}	894 ± 93	940 ± 79
Mg^{2+}	270 ± 22	494 ± 25
Na^{+}	16 ± 7	97 ± 20
PO_4^{2-}	605 ± 15	1,360 ± 25
SiO_2	7.5 ± 1	13.3 ± 8
Zn^{2+}	5.7 ± 0.5	15 ± 1.5

Note: The concentration of the minerals in substitutes of malt.

Source: Moll and Moll (1993).

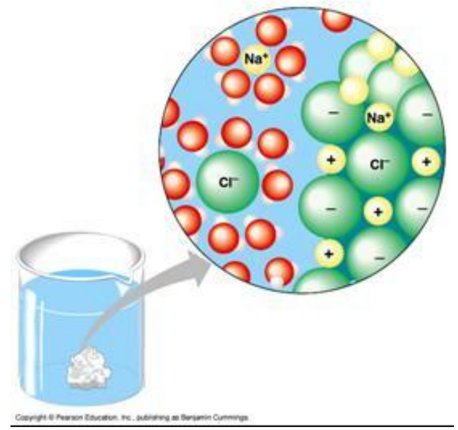
Aporte de aniones en la malta

Jonathan Bruce
Metrohm UK Ltd, Metrohm House, Unit 2, Top Angel, Buckingham Industrial Park, Buckingham MK18 1TH, UK

The majority of anions found in beer are a consequence of impurities derived from the water used during the brewing process. The process of beer manufacture consists of malting, brewing and fermentation followed by maturation before filtration and finally storage. Strict quality control is required because the presence of certain anions outside strictly defined tolerance limits can affect the flavour characteristics of the finished product. The anions present were quantified using the technique of ion chromatography with the Metrohm modular system following sample preparation. The analysis produced a result of the order 200 mg l^{-1} for chloride, phosphate and sulphate and around 20 mg l^{-1} for nitrate. If the chloride level exceeds 250 mg l^{-1}, then the sweetness of the beer is enhanced, but yeast flocculation can be hindered. An excess of sulphate can give a sharp, dry edge to hopped beers and excessive amounts of nitrate have been found to harm the yeast metabolism after conversion to the nitrite form. As water is a primary ingredient within beer, its quality and type is a fundamental factor in establishing many of the distinctive regional beers that can be found in the United Kingdom and is thus monitored carefully.

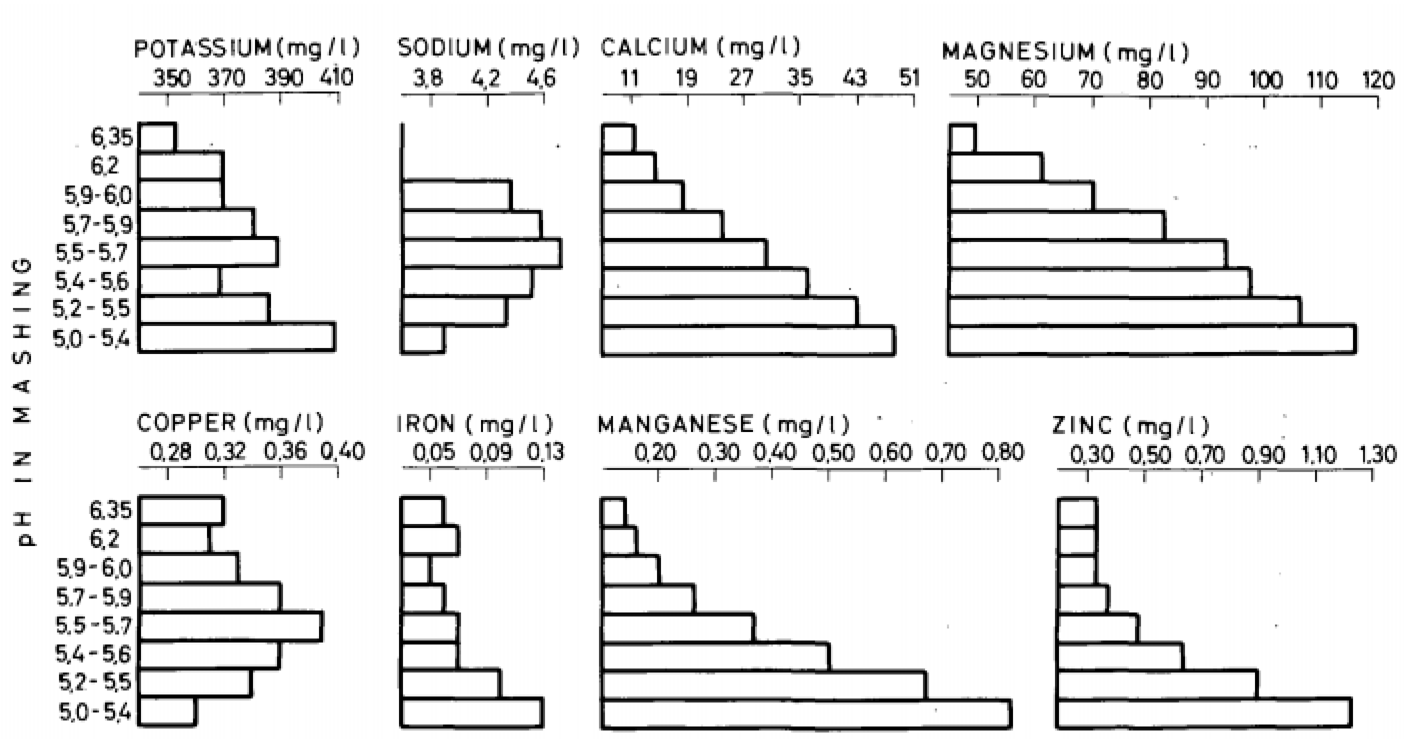
Journal of Automated Methods & Management in Chemistry
Vol. 24, No. 4 (July–August 2002) pp. 127–130

Analysis of anions in beer using ion chromatography

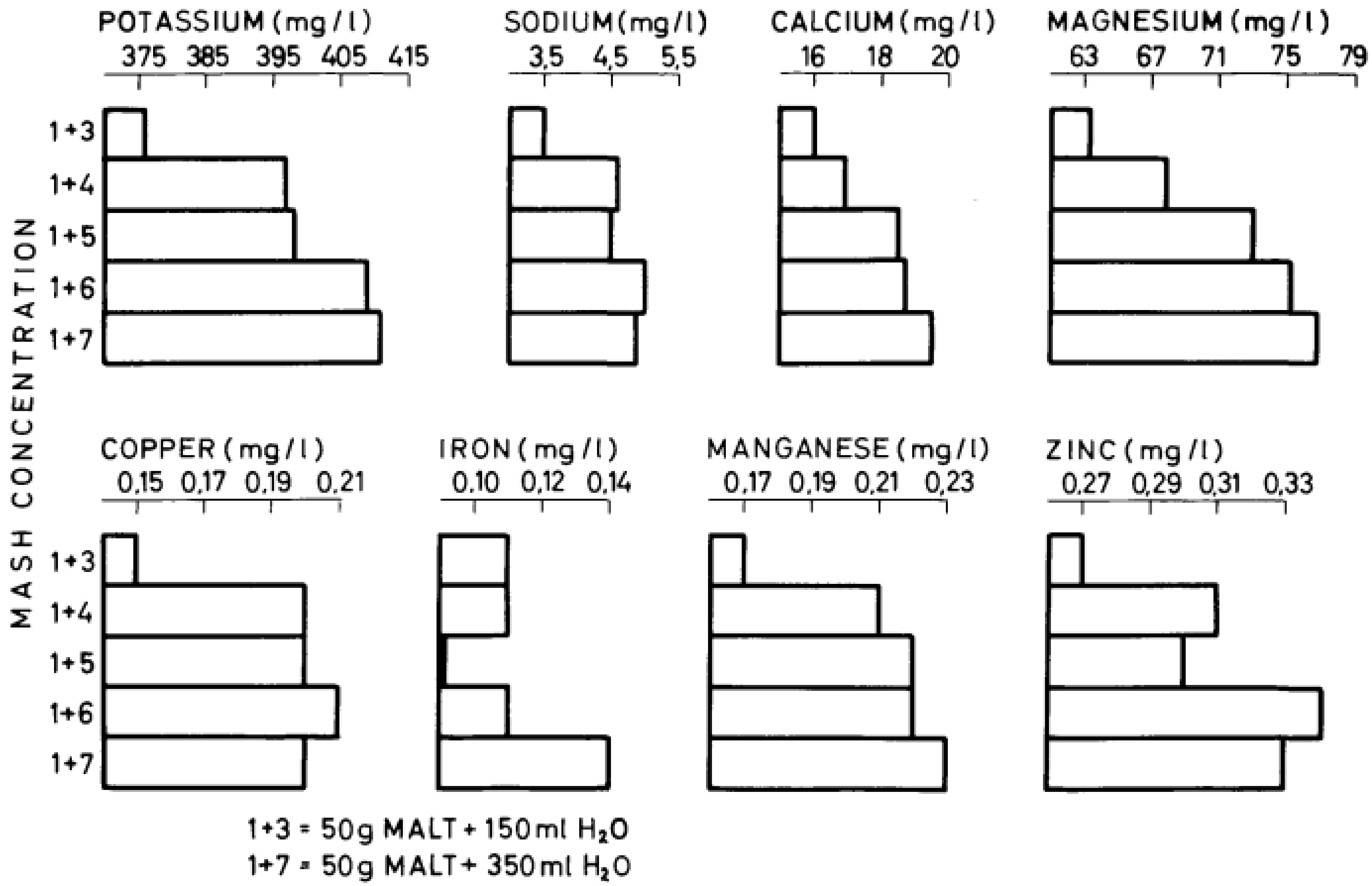


La malta aporta 50 – 100 ppm de sulfato y unas 200 ppm de cloruro (el cloruro puede inhibir la floculación). The New IPA, Scott Janish 2020, pag. 71

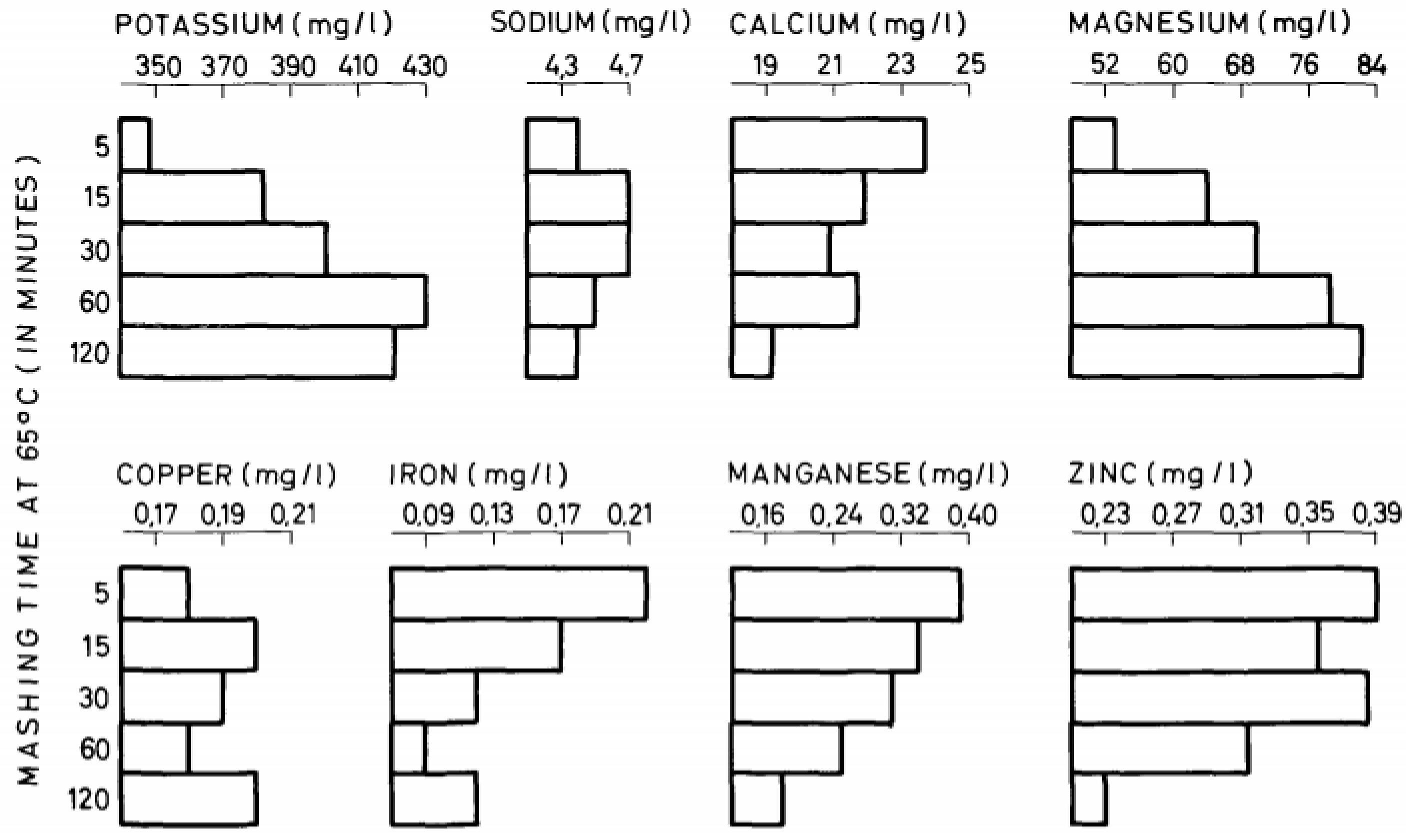
Aporte de minerales de las maltas



Aporte de minerales de las maltas



Aporte de minerales de las maltas



Efectos del proceso sobre el aporte

Table 34.5 Mineral contribution of raw material to the wort (mg/l)

	K^+	Na^+	Ca^{2+}	Mg^{2+}	Cu^{2+}	Fe^{2+}	Mn^{2+}	Zn^{2+}
Malt	556	6	100	184	1.1	6.1	2.1	3.7
Brewing water	3	17	75	21	Traces	0.4	0.04	Traces
Hop	66	Traces	25	9	1.2	0.6	0.3	0.3
Total	627	23	200	214	2.3	7.1	2.4	4.0
Wort 12% *P*	630	24	33	100	0.11	0.05	0.14	0.10
Loss	0	0	83	53	95	99	94	97

Note: The contribution of the different raw materials to the wort minerals and the loss in percent of them after wort boiling during the brewing process due to the formation of insoluble phosphates (e.g. with calcium and magnesium), the formation of salts with the acidic groups of proteins, and the mechanical adsorption on spent grains and trub.

Source: Moll and Moll (1993).

Zinc y Cobre

mabrungard

I spend way too much time on the AHA forum

Posts: 2801

Re: How important are trace minerals in brewing water?
« **Reply #3 on:** April 11, 2016, 02:42:44 PM »

For anyone brewing with RO or distilled water, the number one deficiency is likely to be zinc. Zinc is present in most water supplies at low levels and is typically sufficient for yeast nutrition. However, the RO process reduces that by at least 90% and that leaves the water too low in zinc. The other trace ions seem to be less important for the brewing water or they are supplied sufficiently by the malt.

One option for supplying zinc, is to use zinc sulfate heptahydrate. That mineral is readily available as a nutritional supplement from healthfood and vitamin vendors.

It turns out that ale yeast prefer more zinc than lager yeast. The dosing rate for ales is 3.2 milligrams of the zinc sulfate heptahydrate per gallon of wort. The dosing rate for lagers is half that (1.6 mg/gal). As you can see, these are exceeding small doses and they require exacting measurement since you don't want to overdose the zinc. It creates a metallic flavor at pretty low concentrations. So, DON'T overdo it!!

The other ion that you should include in your brewing practice is copper. It is needed by yeast to scavenge sulfurous compounds from the wort and beer. All you need to do to supply this ion is to have some copper metal somewhere in your brewing system so that wort comes in contact with it. If you have all stainless equipment, I recommend placing a short length of copper tubing in your boil kettle and that should supply all the copper that is needed. Don't worry too much about overdosing with copper since the yeast remove virtually all free copper from the wort and the beer will be almost copper free.

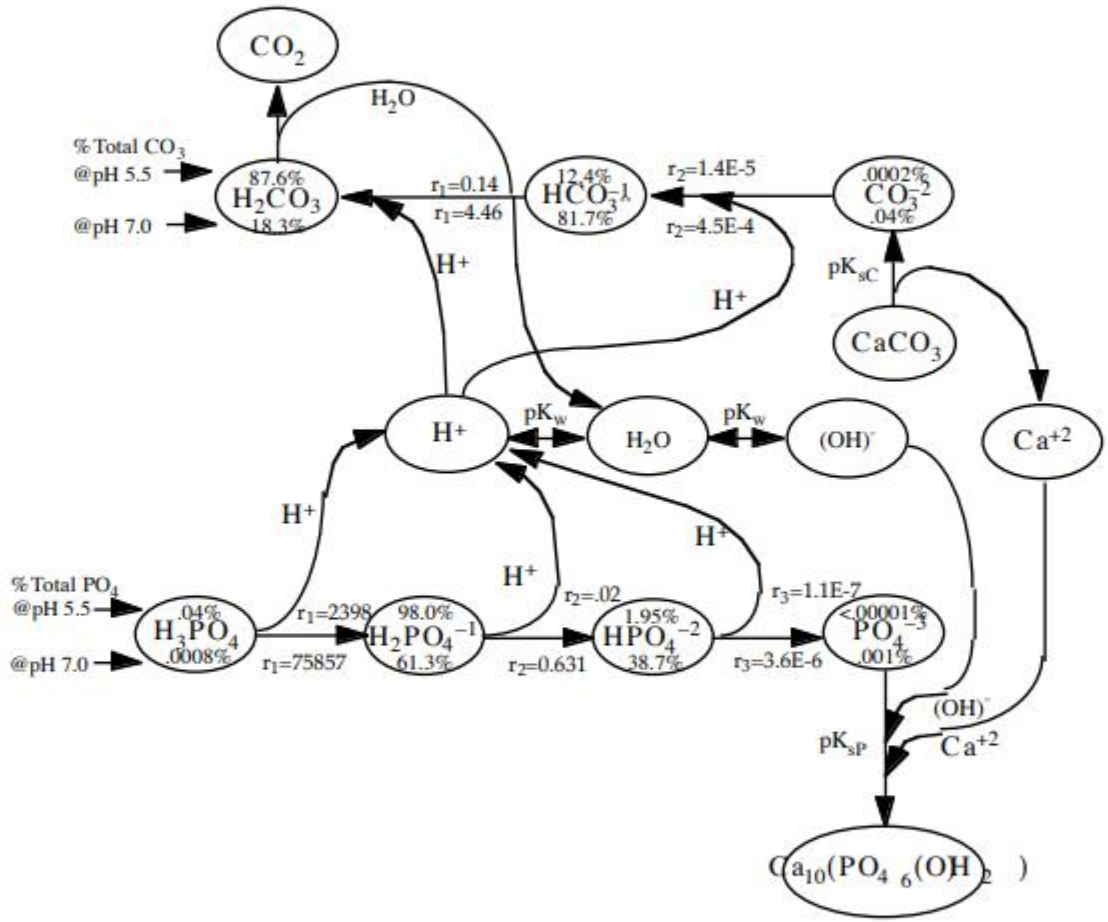
Logged

Martin B
Carmel, IN

BJCP National
Foam Blowers of Indiana (FBI)

¿Es posible que si ajusto el pH del agua de macerado a 5.4, cuando realizo el empaste suba a 5,7?

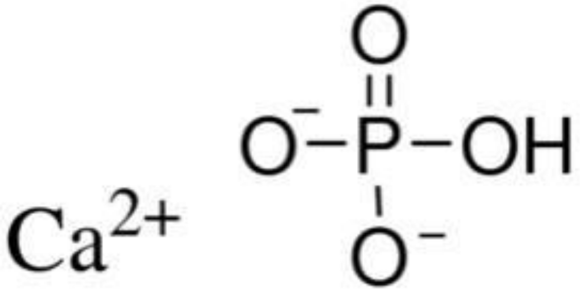
El buffer Fosfato



Recordar...

Agregando calcio y/o magnesio en presencia de malta (empaste)

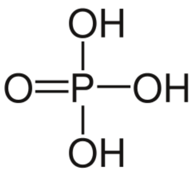
$$HCO_3^- + H^+$$

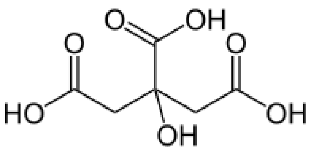


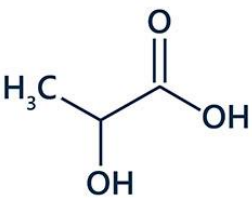
$$CO_{2(g)} + H_2O$$

Tirando de la Cuerda

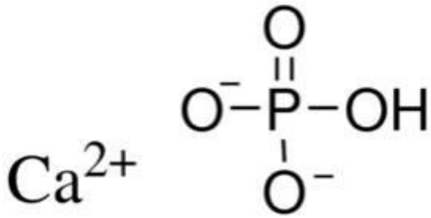
Ácidos grado alimenticio
Fosfórico/Cítrico/Láctico



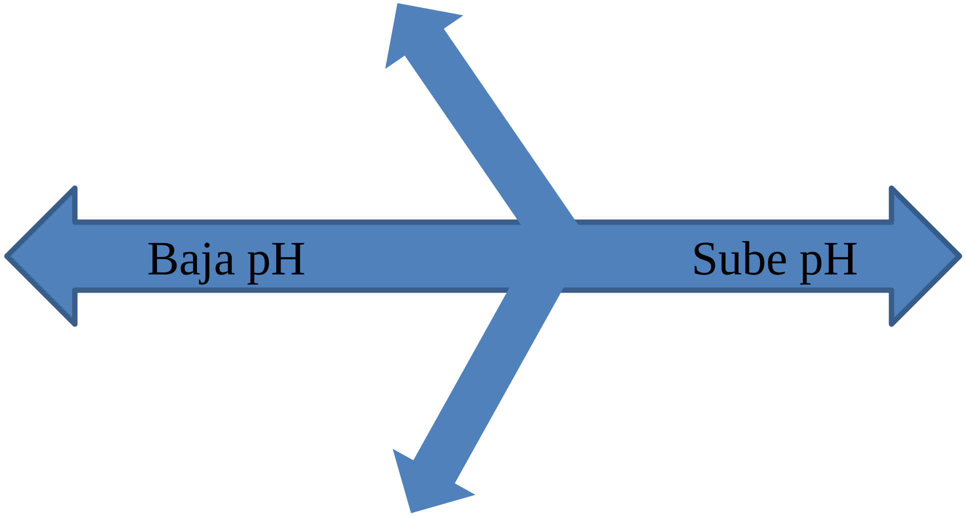


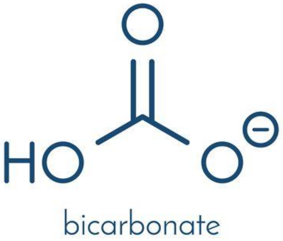


Acidez de las maltas oscuras
Melanoidinas

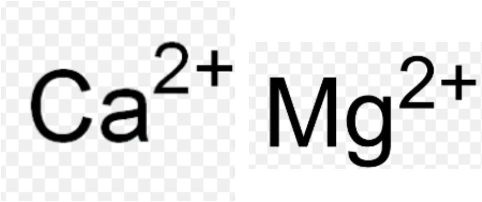


Fosfatos de la malta, se unen con Calcio y bajan el pH





Alcalinidad

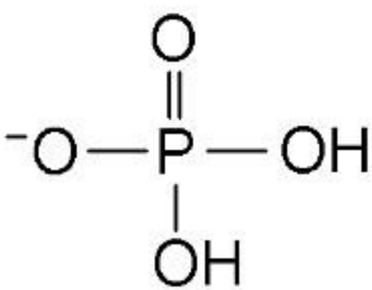


Calcio y Magnesio

Alcalinidad Residual

Habiendo reaccionado ya la totalidad del Calcio, es posible que quede alcalinidad sin neutralizar. Dicha alcalinidad se conoce como alcalinidad residual.

La alcalinidad residual incrementa al pH más allá de que si se usa agua destilada para macerar.



En exceso

Ca^{2+} / Mg^{2+} HCO_3^- / CO_3^{2-}

Si equivalentes de Ca/Mg es mayor que Carbonato/Bicarbonato, entonces no quedará alcalinidad residual.

Si equiv. Calcio/Magnesio es menor, luego quedará alcalinidad residual. Puede ser compensada con agregados de Calcio y/o Magnesio, ácidos o maltas oscuras

Alcalinidad Residual: fórmulas

En ppm:

$$RA = ppm\ Alk - \frac{ppm\ Ca}{1,4} - \frac{ppm\ Mg}{1,7}$$

En mEq/litro:

$$RA = {}^{mEq}/_{L}\ Alk - \frac{{}^{mEq}/_{L}\ Ca}{3,5} - \frac{{}^{mEq}/_{L}\ Mg}{7}$$

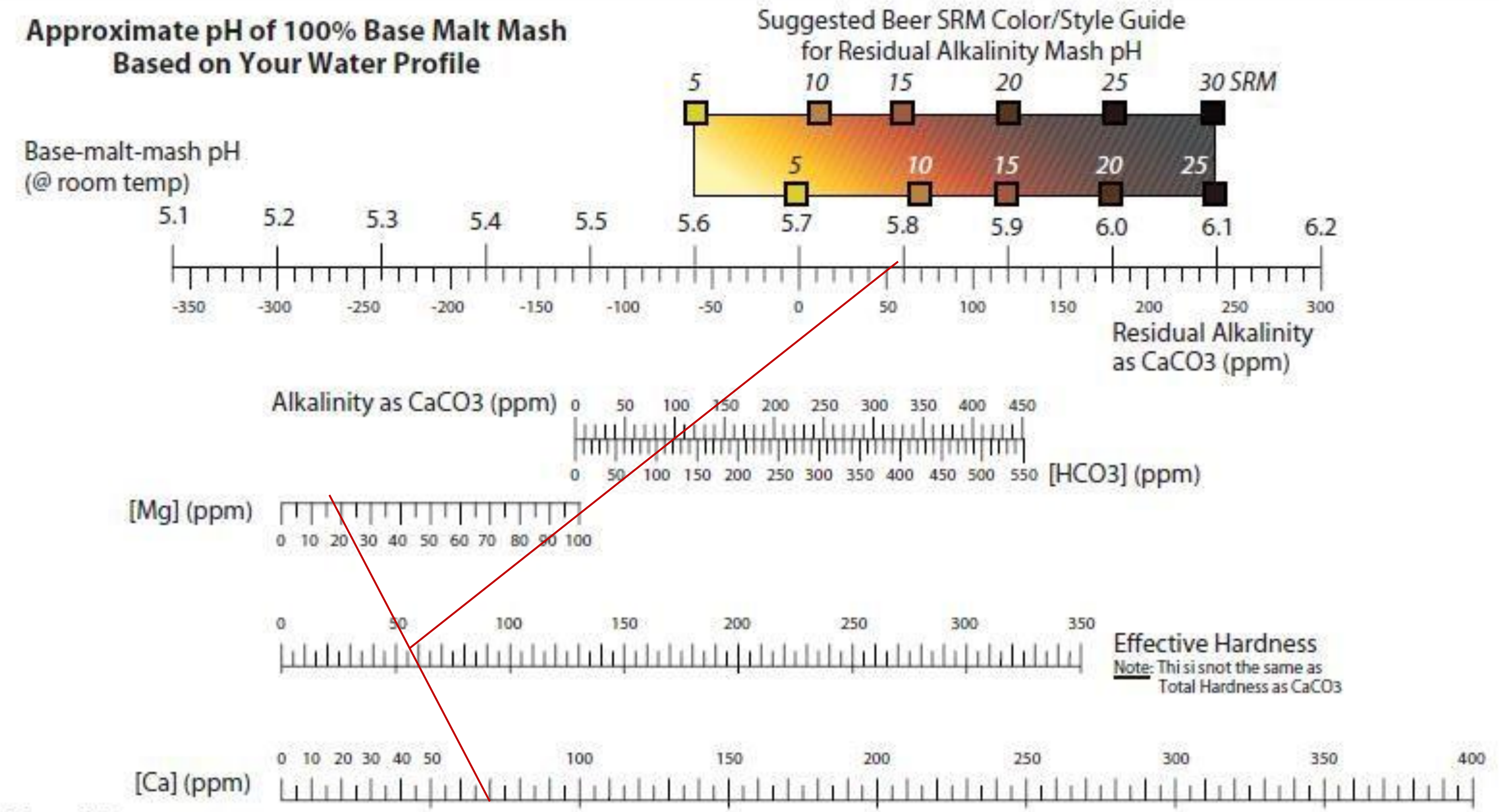
En dH:

$$RA = (ppm\ Alk)x0,056 - (ppm\ Ca)x0,04\ - (ppm\ Mg)x0,033$$

La pregunta es: cuando hago el empaste, ¿qué pH voy a lograr?

Es ahí donde tenemos que unir todos estos conceptos

Procedimiento desde el Nomograma



Usage Notes:
1. Assume a correlation error of +/- .1 pH and a range of at least 5 SRM due to individual mash chemistry.
2. The actual pH of the mash at mash temperature (~150°F) is typically .35 pH less than it measures at room temperature.
3. For best results, the mash pH should always be between 5.2-5.6, regardless of beer style, when measured at mash temperature.

Hay una fórmula aproximada derivada de Troester (2009)

Con agua destilada

$$pH_{mash} = pH_{base} + RAx0{,}03 - (\%cara)x0{,}025 - (\%oscuras_{ligth})x0{,}03 - (\%oscuras_{dark})x0{,}05$$

Con RA en unidades de grados alemanes dH

$$RA = (ppm\ Alk)x0{,}056 - (ppm\ Calcio)x0{,}04 - (ppm\ Magnesio)x0{,}033$$

Procedimiento de John Palmer (Water, 2013)

El método es por prueba y error. Las componentes de alcalinidad de las maltas y del agua se deben sumar, y su suma debe ser igual a cero en el pH final logrado.

- Proponemos un pH final igual al pH objetivo para el macerado, esto es por ejemplo 5,4.
- Sumamos los aportes de alcalinidad y acidez de las maltas y el agua. Si el valor obtenido de la suma es igual a cero, luego el pH que daría el empaste en cuestión sería el propuesto.
- Si la suma es diferente de cero, luego se propone otro valor de pH y se recalcula.
- Se repite este procedimiento hasta lograr la suma igual a cero.
- Otra alternativa es una vez calculada la primera suma, con ese valor estimar la cantidad de ácido a agregar para neutralizar el valor.

La Alcalinidad: la fórmula

Como vimos, la alcalinidad se puede definir como la cantidad de mmol/litro de especies carbonato multiplicada por la «carga de miliequivalentes» (mEq/mmol) que a su vez es función del pH

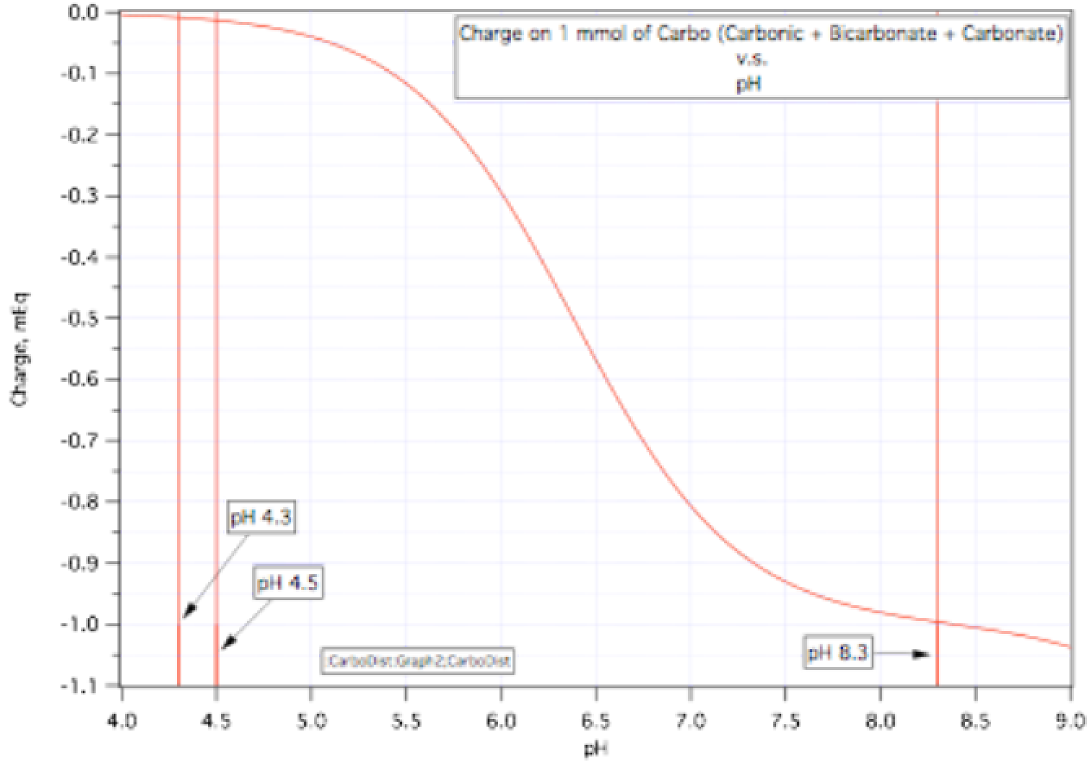
$$Alk_{Agua}\left({}^{mEq}/_{L}\right) = c_T\left({}^{mmol}/_{L}\right) x Carga_{pH}\left({}^{mEq}/_{mmol}\right)$$

La Carga, como veremos a continuación se puede estimar gráficamente

Procedimiento de John Palmer (Water, 2013)

En primer lugar calcular Alcalinidad Z y RA Z. Es decir, ambas respecto al pH del macerado (en lugar de 4,3)

Para ello primero comprender que la capacidad buffer del agua depende de las especies carbonato, que a su vez su distribución y sus correspondientes aportes de equivalentes cambian con el pH (ver figura)



Procedimiento de John Palmer (Water, 2013)

Supongamos el siguiente perfil de agua:

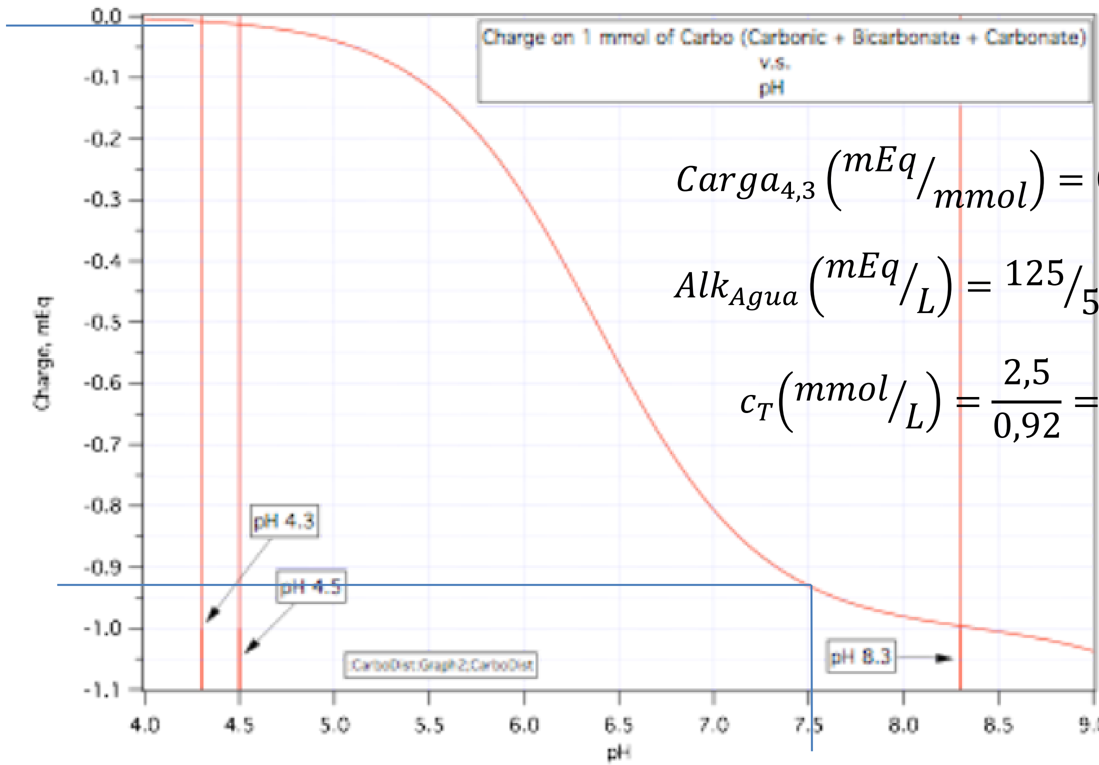
Calcio 70 ppm (3,5 mEq/L)
Magnesio 15 ppm (1,4 mEq/L)
Alcalinidad Total 125 ppm (como $CaCO_3$), (2,5 mEq/L)
Sodio 30 ppm
Cloruro 60 ppm
Sulfato 85 ppm
pH 7,5

Calculamos el c_T (mmoles de especies carbonato/litro)

$$c_T\left({}^{mmol}/_{L}\right) = Alk_{Agua}\ \left({}^{mEq}/_{L}\right)\ /Carga_{pH}\left({}^{mEq}/_{mmol}\right)$$

Procedimiento de John Palmer (Water, 2013)

$$c_T\left(\frac{mmol}{L}\right) = Alk_{Agua}\left(\frac{mEq}{L}\right) / Carga_{pH}\left(\frac{mEq}{mmol}\right)$$



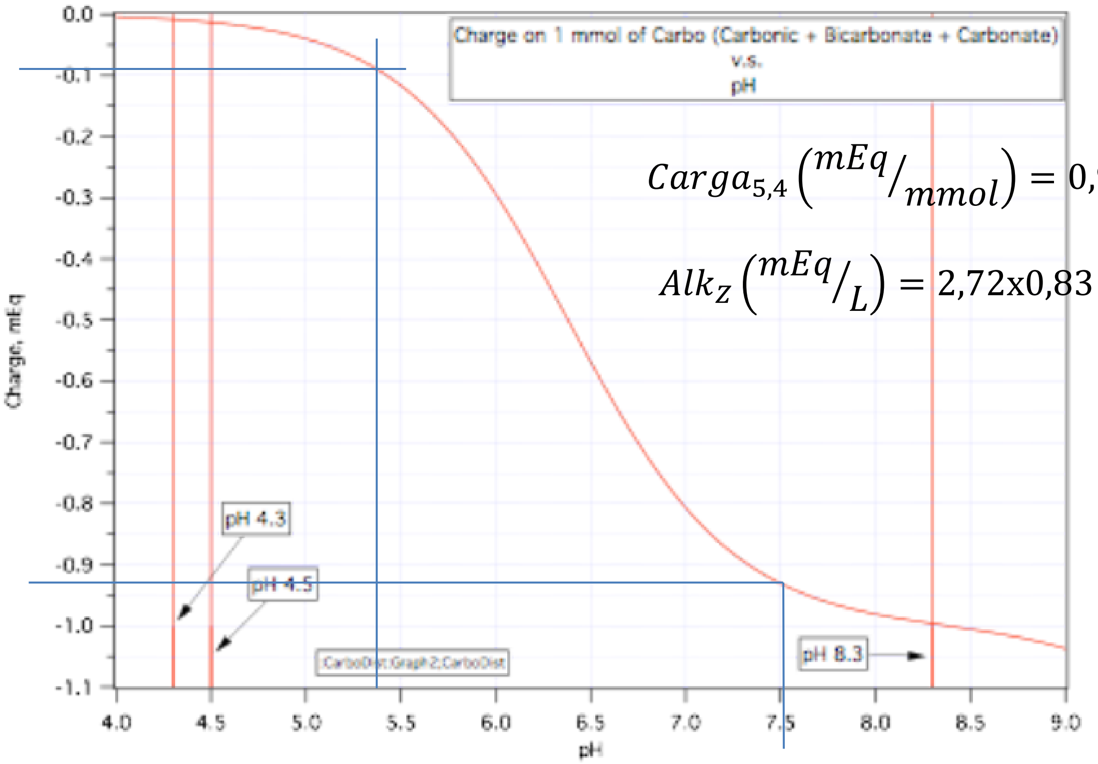
$$Carga_{4,3}\left(\frac{mEq}{mmol}\right) = 0{,}93 - 0{,}01 = 0{,}92$$

$$Alk_{Agua}\left(\frac{mEq}{L}\right) = \frac{125}{50} = 2{,}5$$

$$c_T\left(\frac{mmol}{L}\right) = \frac{2{,}5}{0{,}92} = 2{,}72$$

Procedimiento de John Palmer (Water, 2013)

Paso siguiente calcular la Carga Z y la correspondiente Alcalinidad Z:



$$Carga_{5,4}\left({}^{mEq}/_{mmol}\right) = 0{,}93 - 0{,}1 = 0{,}83$$

$$Alk_Z\left({}^{mEq}/_{L}\right) = 2{,}72\text{x}0{,}83 = 2{,}26$$

Procedimiento de John Palmer (Water, 2013)

A continuación calcular la RA Z:

En mEq/litro:

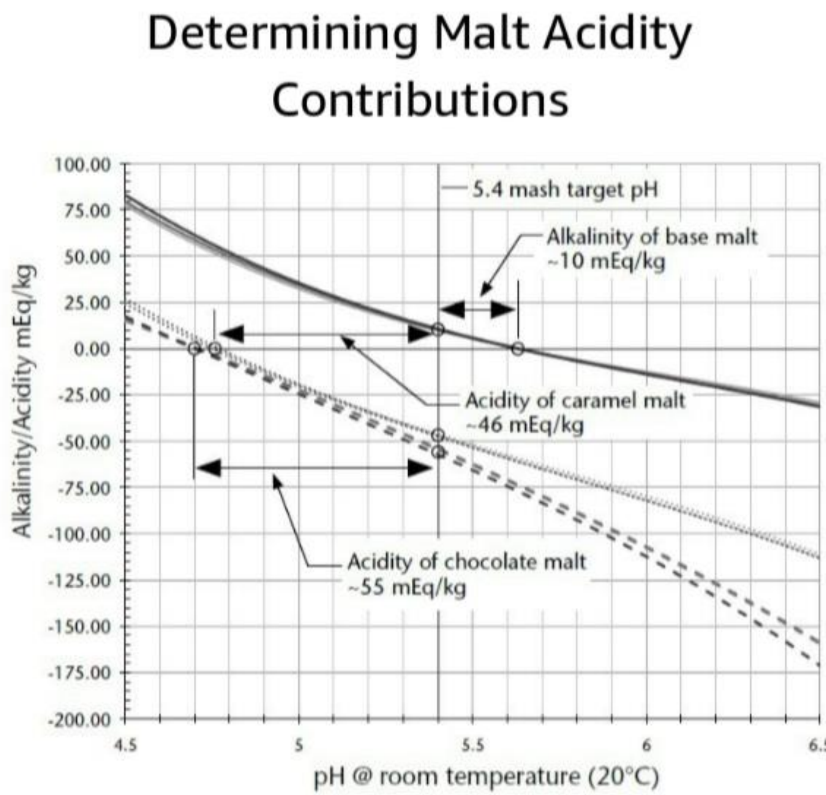
$$RA\ Z = {}^{mEq}/_{L}\ Alk\ Z - \frac{{}^{mEq}/_{L}\ Ca}{3,5} - \frac{{}^{mEq}/_{L}\ Mg}{7}$$

$$RA\ Z = 2,26 - \frac{3,5}{3,5} - \frac{1,24}{7} = 1,08\ mEq/L$$

Procedimiento de John Palmer (Water, 2013)

En paralelo calcular el aporte de alcalinidad/acidez de las maltas respecto al pH target. Para ello nos podemos valer de gráficos como este:

Para nuestro ejemplo en el que se busca un pH 5,4 y si se usa sólo malta base con DI pH 5,62, luego la alcalinidad aportada por la misma será de 10 mEq/Kg



Procedimiento de John Palmer (Water, 2013)

Sumamos los aportes de alcalinidad/acidez de las maltas y el agua según nuestra receta:

Ejemplo, maceramos con 5 kg de malta base y 15 litros de agua, luego

RA Z a neutralizar del agua es 1,08 x 15 = 16,2

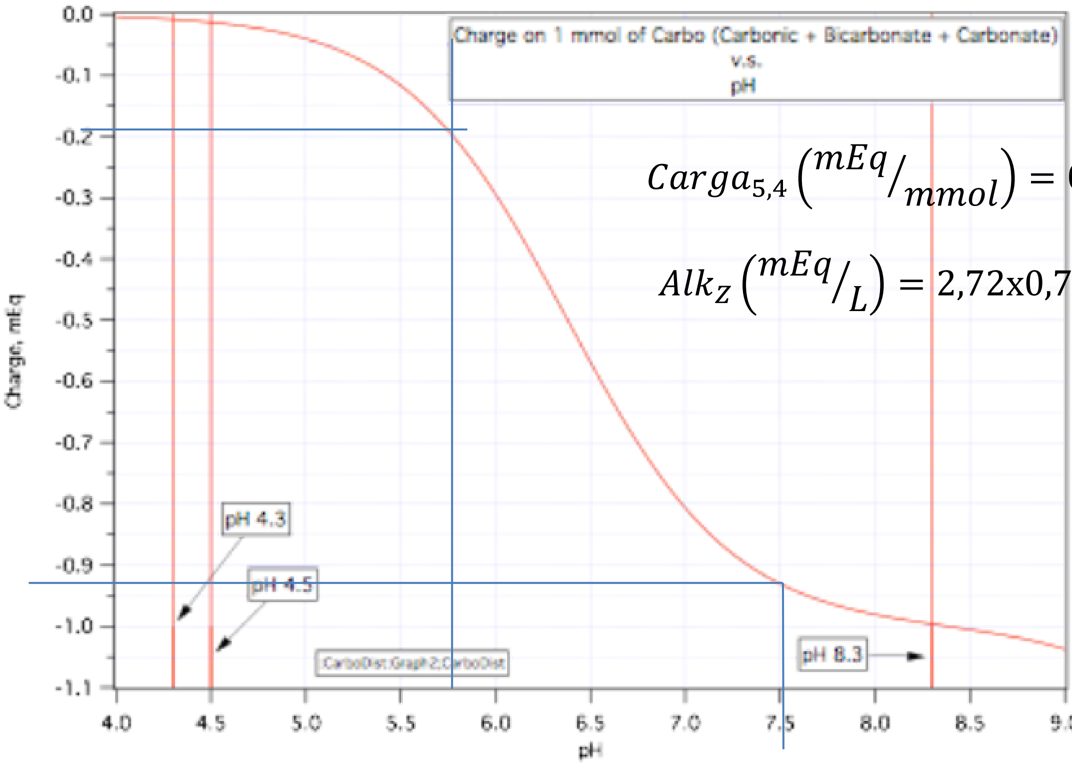
Alcalinidad de las maltas a neutralizar es 10 x 5 = 50

Es decir el valor total es positivo e igual a 66,2 mEq. Como la suma no fue cero, luego el pH de este empaste no sería 5,4, sino que sería mayor.

Proponemos ahora un pH de por ejemplo 5,7, y recalculamos

Procedimiento de John Palmer (Water, 2013)

Volvemos a calcular la Carga Z y la correspondiente Alcalinidad Z pero respecto de 5,7:



$$Carga_{5,4}\left({}^{mEq}/_{mmol}\right) = 0{,}93 - 0{,}2 = 0{,}73$$

$$Alk_Z\left({}^{mEq}/_{L}\right) = 2{,}72\text{x}0{,}73 = 1{,}99$$

Procedimiento de John Palmer (Water, 2013)

A continuación calcular la RA Z:

En mEq/litro:

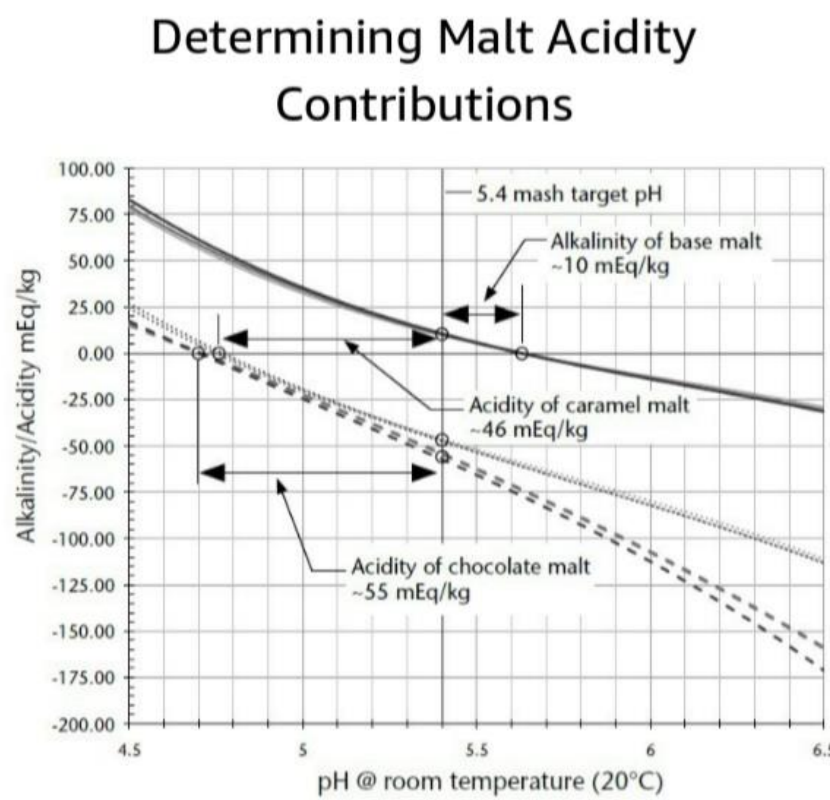
$$RA\ Z = {}^{mEq}/_{L}\ Alk\ Z - \frac{{}^{mEq}/_{L}\ Ca}{3,5} - \frac{{}^{mEq}/_{L}\ Mg}{7}$$

$$RA\ Z = 1,99 - \frac{3,5}{3,5} - \frac{1,24}{7} = 0,81\ mEq/L$$

Procedimiento de John Palmer (Water, 2013)

Recalculamos acidez/alcalinidad de las maltas:

En este caso hasta 5,7 la acidez ahora aportada por la misma será de 3 mEq/Kg



Procedimiento de John Palmer (Water, 2013)

Sumamos los aportes de alcalinidad/acidez de las maltas y el agua según nuestra receta:

Ejemplo, maceramos con 5 kg de malta base y 15 litros de agua, luego

RA Z a neutralizar del agua es 0,83 x 15 = 12

Acidez de las maltas a neutralizar es -3 x 5 = -15

Es decir el valor total es negativo e igual a -3 mEq. Podemos asumir este valor aproximadamente cero, o bien recalcular con un pH algo menor, por ejemplo 5,68.

El mismo problema, aplicando la fórmula derivada de Troester da:

$$RA = 125x0{,}056 - 70x0{,}04 - 15x0{,}033 = 3{,}7$$

$$pH_{mash} = 5{,}62 + 3{,}7x0{,}03 = 5{,}73$$

Cálculo de cantidad de ácido a agregar

Conviene en general preparar soluciones de ácido en concentración 1 N (1 mEq/ml).

Para ello mezclar 68 ml de fosfórico al 85%, o bien 84 ml de láctico al 88% y llevar a 1 litro de agua (siempre agregar el ácido sobre el agua)

Luego si necesitamos neutralizar 66 mEq de alcalinidad del agua y las maltas deberíamos agregar 66 ml de la solución 1N de ácido.

Para el ácido cítrico que es sólido, 1 mEq de cítrico equivalen a 0,064gr (con lo cual habría que agregar unos 4 gramos en este caso)

Nuestros datos

Canal de YouTube
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