WATER HARDNESS

(Facts or Fiction?)

Introduction

I have been asked on numerous occassions by Koi enthusiasts to explain the importance of Gh & KH. I will endeavour to explain this complicated subject without the proper chemical terminology. This, I believe will help more enthusiasts to grasp the importance of maintaining correct levels of both Gh & KH. I would also like to state that these are not my own opinions, but scientific facts.

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Osmosis

Osmosis is the effect of a stronger solution (in this case body fluids) diffusing to a weaker solution (fresh water). Koi draw fresh water through their gills and extract vital minerals salts, the majority of these salts are then lost through skin tissues via the constant process of osmosis. When we observe koi we see a body mass covered in skin and scales. It is easy to assume that they are solid when in truth 80% of this body mass is fluid. Koi possess a very thin semi-permiable membrane commonly know as the epithelium that allows water and small particles to pass through.

If the Koi body fluids were to be dissolved by the constant influx of fresh water the fish would die. So we can clearly see that Koi need to maintain a higher concentration of body salts to offset the effects of osmosis. Koi achieve this by constant urination and can urinate approxamately 30% of its body weight per day.

During this time their highly efficient kidneys remove the mineral salts a process called (osmoregulation). The osmoregulartory system is therefore very dependant on the mineral content of their watery enviroment.

Water Hardness

There two types of water hardness, namely (permanent and temporary) - the sum of which is reffered to as General Hardness (Gh). water is deemed to be soft or hard depending on the concentration of mineral salts. the most common minerals that are found in water are Calcium and Magnesium.

The most commonly used test for measuring hardnes is (The German Method) which measures hardness in degrees (dH). Each degree is equal to 17.4 ppm. The test utilises a reagent that reacts to a water sample and changes colour. One drop of reagent would be equal to one degree of hardness. *(See Figure 1 Below)*

Figure 1 - *Typical water hardness levels*

DEGREES OF HARDNESS (dH)	WATER
0 - 4 dH	Soft
4 - 8 dH	Moderate to Hard
8 - 16 dH	Hard
16 dH +	Very Hard

(Ideal level for Koi Is 10 dH)

In the UK the tendency is for water to be very soft due to low concentrations of mineral salts, this forces Koi to work much harder to osmoregulate. By increasing water hardness, you decrease the workload on the kidneys, enabling the Koi to cope with osmosis without any undue stress.

Carbonate Hardness KH

More commonly referred to as alkalinity or temporary hardness. The ponds abilty to resist changes in pH is reliant on alkalinty. It does this by constanly acting as a buffer releasing carbonate ions when pH levels rise or fall. These carbonate ions are used up over a period of time and need replenishing. this can occur naturally through water changes. Tap water in the UK contains low and, in some cases, no alkalinity at all. The need to supplement pond water is therefore vital. Again we can test for (KH) degrees of German Hardness. One drop of reagent represent one degree of hardness of which ideal levels are shown in figure 2 below.

Figure 2

DEGREES OF HARDNESS (KH)	WATER
0 - 2 dH	Low
4 dH	Minimum
6 dH	Ideal
>7 dH	Too High

(It is undesirable to raise KH levels above 7 as this has a tendency to raise Ph)

pH

pH tells us if our pond water is acid or alkaline. pH is measured on a scale of 1 - 14 with 7 being neutral. Koi prefer a pH between 7 and 8.5. however many things can affect pH, for example if the ponds pH is measuring over 8.0 and contains low hardness any heavy metals contained in that water will be in solution and very toxic to Koi. In contrast pH levels below 8.0 and being slightly harder, potential harmful metals will be particulate and will settle out. Another problem associated with pH is ammonia. Ammonia levels at or below 7.2 will be ionised and less toxic to Koi. Unfortunately once pH returns above 7.2 ammonia will become toxic again.

So once again we see the importance of many correct GH and KH levels. If we look at pH more closely we are actually measuring two ions.The hydrogen ion which measures acidity and the hydroxyl which measures alkalinity, in simple terms if the pond water contains more hydroxyl ions than hydrogen ions (which is normally the case) your pH is going to be more than 7.0 and alkaline conditions would prevail. The natural process of pond water is to become more acidic over a period of time. Nitrifying bacteria consume oxygen and release carbon dioxide, this in turn mixes with water to form carbonic acid, an action which reduces ph. In order to counter this hydroxyl ions are released that absorb hydrogen ions thereby stabilising the pH. When pH levels increase, a hydrogen ion will release its hydroxyl ion, causing a reduction in pH by releasing acid. We can now see that a stable pH is dependent on proper KH levels being maintained.