Vegetable Fermentation

The Essential Guide

Celestial Roots

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Introduction

Welcome to my book, within these pages you will find all you need to know to commence safe and effective vegetable fermentation. Firstly, let's start with two quotes, the first addressing the safety of fermented foods, the second looking at the exciting new area of fermented foods and mental and psychological equilibrium.

"As far as I know, there has never been a documented case of food-borne illness from fermented vegetables." – Fred Breidt, microbiologist for the US Department of Agriculture specialising in vegetable ferments.

"How (these) differences in our microbial world influence the development of brain and behavior will be one of the great frontiers of clinical neuroscience in the next decade." - Thomas Insel, Director of the (US) National Institute of Mental Health.

The simple fact is that we have co-evolved with our inner communities of probiotic organisms to such an extent that every system in the body begins to break down when our internal ecosystem is out of balance. The human microbiota (what scientists call the totality of our inner communities) has been under an unsustainable level of attack in recent times, and the fermented food revival is one answer to this problem. There are other answers too of course, and my ebook on calming and repopulating the gut touches briefly on these and offers tools to counter them. Upon reading that book, you will discover that there is far greater benefit to be derived from eating fermented foods if we first address inappropriate systemic inflammation, eliminate our own individual trigger foods from the diet, calm and heal the gut, and then repopulate with fermented foods.

In closing this introduction, I would like to testify with all the fervour of the convert (fervour and ferment come from the same Latin root word): in brief, we used the protocol outlined in my book and regular and varied fermented foods to successfully address my wife's severe degenerative multiple sclerosis, and, through a healthy diet rich in clean and living foods, our family never gets sick. Now, with that best of recommendations, let's look briefly at fermentation.

Fermentation 101

There are four modes of fermentation, and these involve bacteria, yeasts, moulds, or chemicals. Furthermore, many ferments are hybrid ferments, relying on two or more pathways. Examples of these are tempeh, where both mould and bacteria are involved, and beet kvass, where bacteria and yeasts are involved. We are concerned primarily with what is called lactobacillic fermentation – the fermentation of a substrate (fancy term for 'stuff the microorganisms eat') by a procession of bacterial communities culminating in the climax community dominated by lactic acid bacteria (LAB for short). They are called lactic acid bacteria because as they consume the sugars in the substrate, their main output is lactic acid and carbon dioxide. LAB are not the only players in LAB fermentation though – for example, in the initial phase of fermentation of vegetable matter, enterobacteria (including probiotic strains of *E. coli*) and yeasts play their part. Just so you know this is a natural thing, the procession of bacteria we see as sauerkraut ferments is pretty much the same procession during the colonisation of the new born human gut. This in fact is crucial for my gut repopulation protocol, as found in the gut calming and repopulating ebook, and is a testament to the naturalness of fermentation as a food preservation and augmentation technique.

Vegetable ferments are salted for very good reason, and this is to create the correct environment for the bacteria we want, while excluding those we don't

want. Food Standards Australia and New Zealand recognise the change in pH that occurs during fermentation as one of the fail-safe methods of safe food preservation, and this is the change that is mimicked by vinegar pickling, another approved method. If we salt our vegetables in accordance with the guidelines given here, what we are doing is setting the perfect environment for the primary fermentation species. Once favoured, these bacteria actively work to modify the environment to suit the secondary fermentation species, which at the same time excludes pathogenic species. This process is discussed in detail in the section on sauerkraut, all we need to say here is that good quality vegetables, good quality water (if needed), and good quality salt within a broad but well-defined range equals safe fermentation.

It goes without saying that all equipment wants to be sterile to begin with, and basic good hygiene as practised in the home kitchen is all we need. Anti-bacterial products are not only unnecessary for fermentation cleanliness, they can actually be counter-productive, because we are using wild bacteria to ferment our food. Talk of equipment leads us nicely to the brief section on fermentation equipment, so let's go there now.

Equipment

Vegetable fermentation is easy! The fate of all organisms disconnected from the life-source is decay; it can be no other way. Lactobacillic fermentation of vegetable substrates is a human directed process that may be viewed as 'controlled spoilage', where our control achieves beneficial change (preservation and augmentation) rather than food spoilage. We direct this process with the addition of salt, which creates an environment that favours probiotic organisms while preventing colonisation by pathogenic organisms. Many vegetable ferments require no added brine – rather the vegetables are salted and massaged, pounded, or compacted until the salt draws moisture from the vegetables. With care, this brine rises to cover the vegetable matter. It is crucial that the vegetables are covered with brine to reduce oxidation and

mould formation on matter exposed to the air. On occasion, not enough moisture is held within the substrate to produce sufficient brine, so we then make up brine to top up the fermenting vessel. Depending on taste and experience with different vegetable ferments, this brine will be between 1 – 3 tsp of salt per cup of water. The addition of salt makes vegetable fermentation not only easy, but safe.

Vegetables float, and there are strategies we may employ to keep them submerged. All these strategies involve weighing down the vegetables with some food and fermentation safe item. Glass, ceramic, hardwood, and stone are the most common, but stones must be smooth, non-porous, and well scrubbed and boiled. Items I use include: glass platters, lids, paperweights, jars, egg cups, shot glasses, ramekins, jugs and bowls; and good quality unchipped ceramic plates, saucers, and bowls. What I use depends on the fermenting vessel I am using, and I have found the perfect weight that fits each vessel snugly either in our cupboard, or from op shops.

Water moat crocks are available widely and consist of a glazed ceramic crock with a deep, enlarged lip in which the lid sits. The lip, or moat, is then filled with water, which prevents the entry of oxygen while allowing pressurised CO_2 to escape. In effect, the water moat is a simple airlock. These crocks are always supplied with weights – two half circular ceramic sections, sometimes glazed, that when lain carefully over the cabbage form a circle that snugly fits the diameter of the crock. As long as the crock is well set up, the only thing we need be concerned about is loss of the water in the moat which may occur in two ways. The first mystery of the disappearing water is one we can all guess with ease – evaporation. The second mystery is a little more tricky, and while the effect is the same, it gives us clues as to when it might occur, and how to prevent it. Gasses expand when heated, and contract when cool, and since our crock with moat maintains a facsimile of a one-way vacuum within it, if the crock cools substantially, the contracting force of the gasses can draw water out of the moat, and into the crock. This most often retains a seal if the lid is a good fit to the moat via a thin film of water that adheres between the two, and

we look out for this in the morning if the overnight temperature has been markedly cooler than the daytime temperature. Whenever we see an empty moat, we fill it up just to be safe. Sometimes water is held in suspension under the lid, and comes back into the moat with pressure normalisation – in that case, we spoon the excess out. Because water can be drawn into the crock from the moat, we fill it always with brine at roughly 2% or 1 teaspoon of salt (roughly 5 g) per cup (250 ml) of water. Strategies for reducing water loss are the laying of a damp cloth over the lid and moat for loss via evaporation, and maintaining a more constant temperature with a heating pad or insulating jacket for loss via pressure change.

An airlock jar is simply a glass jar with a screw top lid that has a small airlock in it. The airlock is either an exaggerated sideways 'S' shape or a small cylinder nested within a larger one, both with chambers for water that again prevent oxygen entering, but allow CO_2 to escape. These may be purchased (e.g. Ball or Weck both do airlock jars), or a home version will suffice at a fraction of the cost. Simply find a suitable size repurposed jar with a metal lid, and purchase an airlock and bung from a home brew supplier. Drill a hole the diameter of the midpoint of the bung, sand and clean the hole so it is neat, then push in the bung and airlock. The airlock is held upright, and filled with water to the level of the line marked on the side. You will see bubbles coming out of the airlock as fermentation commences, and an indication that fermentation has neared completion is a slowing or apparent lack of activity in the airlock. A rolled cabbage leaf cap and some kind of weight are still necessary.

Rubber sealed jars come in several types; the kinds I use are Italian-made Fido jars with a rubber seal and a metal bail arm type clip, and Australian-made Fowlers Vacola preserving jars. Most Fido jars will off-gas under sufficient pressure, but a caution here – some jars, particularly with brand new seals, may not off gas. Excess CO_2 can lead to explosions, the way to check for off-gassing is to put a little pressure on the lid of a ferment that has been set a few days without removing the bail arm clip – if you hear a little hiss, the seal is loose enough for our needs. Fowlers jars are straight sided and come in various

sizes. They are very good quality glass, with a recessed groove which holds a rubber O-ring. A stainless steel lid covers the jar and comes down over the O-ring, and is held in place with a metal clamp. The ring is designed to create a vacuum when canning produce, after which the clip can be removed for storage in the pantry. For fermentation use the clip is left in place, and the ring effectively excludes oxygen while allowing off-gassing. The Fowlers No. 31 jar (with a 4 inch diameter and comfortable 750 ml capacity plus headspace) is the size I use for small batch ferments. I use the cabbage leaf plug, and a stack of glass Mason jar lid inserts as the weight. Glass paperweights or candle holders can be used in the same way. I stack them until they are just proud of the rim of the jar then clamp the lid on, which pushes them down on the cabbage. I have never had kahm yeast, mould, or oxidised vegetable matter using this system, and I have never had a jar explode.

If fermenting in a Mason jar, or a repurposed jar, we will need to release pressure during the early stages of fermentation. The best way to do this is to open the lid carefully until we hear a hiss of escaping gas, then immediately closing the lid to prevent any air getting in. A plug and food-safe weight are still required for these ferments.

Open crock ferments, that is a crock without a moat but still with a lid, is fine for short ferments, but over the course of a six week sauerkraut ferment, the likelihood of mould developing is high. As discussed in the section on mould, diverse moulds produce such a variable and potentially debilitating or fatal array of mycotoxins I long ago abandoned making sauerkraut in open crocks, and recommend the same to anyone who seeks my opinion on the matter.

Sauerkraut preamble

In 1776, Captain James Cook was awarded the Copley Gold medal by the Royal Society for his observation that sauerkraut included in the diet of his

crew helped prevent the vitamin C deficiency condition we know as scurvy. In the age of sail, more men died of scurvy in the British Navy than from all other causes combined, including battle. Like many vegetables, cabbage is high in vitamin C when fresh. The fermentation of cabbage, while reducing the vitamin C content slightly, retains the vitamin for extended periods, and increases its bioavailability.

For Cook's voyage on *HM Bark Endeavour*, the sauerkraut was boiled to reduce it for preservation, which would have reduced the stable vitamin C content slightly through conversion of some l-ascorbic acid to dehydroascorbic acid, but the high temperatures involved would have deactivated the enzyme ascorbic acid oxidase which renders dehydroascorbic acid to a biologically inactive form. Some loss would have occurred as the sauerkraut was heated up to the temperature of enzyme deactivation, but since most vitamin C loss is through leaching to water, the reduction of the brine through evaporation would have preserved the leached vitamin. Some of Cook's other strategies of including malt wort, carrot marmalade and preserved citrus in his crew's rations; forbidding them to eat the fat scrubbed from the galley's copper pans (copper compounds formed would have oxidized vitamin C in the body); and his instruction of the ship's botanists to identify likely fresh greens for consumption at each landing place combined with the sauerkraut to ensure adequate vitamin C and other nutrients were available to his men. Cook managed to circumnavigate the globe at the helm of *Endeavour* without losing a single man to scurvy, and sauerkraut certainly played no small part in this.

The fermentation of cabbage most likely pre-dates recorded history, both in Europe, and in Asia. Suan cai (literally 'sour vegetable') was a staple for workers constructing the Great Wall of China, and contemporary accounts detailing the day to day life of the project are our first written accounts of fermented cabbage. The preservation of cabbage and turnips by salting is mentioned by the Roman writers Cato and Columella, and Plinius the Elder, writing in the first century of the current era, described the production of salt-cabbage for preservation in earthenware crocks. Rumour has it, as they say,

that sauerkraut in its present form was introduced to Europe via China by Genghis Khan, where it became a staple of Eastern European and Germanic cuisines. Fellow fermentation researcher and teacher Lance Hancherow calls sauerkraut the “great enabler of world conquerors”, so pivotal was the role played by sour cabbage in all its forms in the mass movement of troops in the pre-industrial age. Lance relates the tale of his Cossack grandfather racing across the steppes to defend the Russian frontier in the late 19th century, riding day and night, with the Russian version of sauerkraut (kisla kapoosta) in his saddlebags, a necessary supplement for both man and horse.

Later on, we will look at recipes not only for sauerkraut as we know it, but also for kisla kapoosta, suan cai, and a Croatian technique for whole cabbage head fermentation that would surely resonate with the ancient Romans mentioned above. Before then, we will learn all about the fermentation process as it relates to cabbage (with a little help from some painless science); we will learn all about potential pitfalls and how to avoid or troubleshoot them; we will discuss mould, histamine, goitrogens, and the toxic effects of conventional agricultural practices; and we will learn how to set the ecosystem parameters that ensure a safe and successful ferment. In the pursuit of safe and beneficial fermented foods and beverages, ecological concepts such as environmental constraints or ecosystem parameters are important, and we find that like the natural world, we can manipulate things to our advantage if we understand the reactions and requirements of the organisms involved. An ecosystem parameter is a variable, measurable property whose value can be used to help define or limit the extent of an ecosystem and its functionality. We may, if we wish, manipulate one variable to increase or decrease the value or output of another variable, and this is something humans are fairly good at. Incorporation of organic matter into soil is an example of adjusting an ecosystem parameter with a definite goal (or goals) in mind: we may wish to counter soil acidity, influence soil moisture holding capacity, increase yield, or we may wish to do all three of these. As we all know, ecosystems are fairly complex, so the more we can understand about the environment we wish to influence, and about the interrelated impacts of our adjustments, the better

off both we and the ecosystem we seek to manage will be. First of all however, we will look at the question "why sauerkraut?"

Why Sauerkraut?

In my opinion, sauerkraut is the undisputed champion of fermented functional foods. Just as our bodies can only ever be as good as the raw materials we put into them, the efficacy of our functional food ferments relies in no small part on the ingredients we use. Assuming we are using the perfect cabbage (more on that later), what we are talking about here are the nutritional and medicinal virtues of this humble and much overlooked crucifer. While most of us associate sauerkraut primarily with green cabbage, I am going to encourage you to use red cabbage as well, either on its own, or mixed with green cabbage. This is because from a functional food perspective, fermented red cabbage is the champion of champions.

Cabbage is a very low glycemic index (GI) food that is low in calories, and high in fibre. It is an excellent source of vitamins K, C, and B6, a very good source of manganese, potassium, B1, folate, and copper, and a good source of choline, phosphorous, B2, magnesium, calcium, selenium, iron, pantothenic acid, B3, E and A. Analyses reveal that while all cabbages are excellent foods from both a nutritional and functional food perspective, different varieties contain differing levels of some key nutrients and phytonutrient compounds. For example, Savoy cabbage is highest in the isothiocyante compound sinigrin (shown to have potent preventative action against colon, bladder, and prostate cancers), white drum cabbages offer enhanced preventative and healing actions for breast cancer, bok choy has more beta-carotene and vitamin A than any other cabbage variety, and red cabbage is highest in both vitamin C, and in antioxidant and anti-inflammatory actions due to the anthocyanin polyphenols that provide the colour. So to get the most benefit from the mighty cabbage, utilise as many varieties as you can, and eat them either lightly steamed, gently sautéed in bone or vegetable broth, or fermented. Slicing your cabbage and

letting it sit for five to ten minutes before cooking will enhance activation of all therapeutic compounds, and we will look at those now to encourage you to do this.

Much of the cancer-fighting reputation of cabbages in general, and sauerkraut in particular, stems from a range of compounds called glucosinolates. Glucosinolates are part of the cruciferous vegetable defence mechanism against herbivory. They are inert substances until activated by the accompanying enzyme myrosinase. In the plant tissue, glucosinolates and myrosinase are segregated, but the action of chewing breaks down the compartment walls, and the formation of what is fundamentally a range of irritant and toxic chemicals is initiated. In humans, high doses of these toxins are required to initiate substantial effects, and it would be hard to eat enough cruciferous vegetables to cause us harm. Where cabbage is included as one part of a balanced diet, there is nothing to fear from the glucosinolates, even those whose metabolic fate is to become one of the compounds known as 'goitrogens', an out-dated and somewhat unscientific label for compounds that can impact on thyroid function in thyroid-compromised or iodine (and related nutrient) deficient people at high doses. Fermentation of cabbage, however, does actively result in reduction of the primary goitrogen (goitrin), so sauerkraut and other fermented cruciferous vegetables are even less likely to cause problems for vulnerable individuals. I address the issue of cruciferous vegetables, goitrogens, and hypothyroidism in a separate publication.

Glucosinolates are sulphur-bearing glucosides that are broken down by the myrosinase enzyme to yield a complex array of products. The indole glucosinolate glucobrassicin, for example, yields an unstable isothiocyanate that further degrades through the loss of sulphur into the benzopyrrole indole-3-carbinol, ascorbigen, and related compounds, all of which have been demonstrated as anti-carcinogens. The anti-carcinogenic actions of the various compounds derived from all glucosinolates include induction of apoptosis (programmed cell death) in cancerous cells, destruction of cancer stem cells (and subsequent decrease in secondary cancers), reduction in the proliferation

of cancer cells, induction of the phase 2 enzymes necessary for the detoxification of potentially carcinogenic xenobiotic compounds, and potent antioxidant and anti-inflammatory activity. One compound, phenethyl isothiocyanate, has been found to be more effective against cervical and other cancer stem cells than either chemo or radiation therapy. Cancer stem cells make a strong contribution to cancer recurrence, and these cells are at best poorly affected by radiation or chemotherapy, and at worst, therapy resistant stem cells can be generated from less aggressive cancer cells as a result of these treatments. There is a route by which our immune system induces the death of cancerous cells (cytokine tumour factor-related apoptosis-inducing ligand), but cancer stem cells are frequently resistant to this mechanism. It goes without saying there are no side effects to using cabbage or other brassicas as functional foods in an anti-cancer context, though this one measure alone should not be expected to prevent or cure cancer where other beneficial dietary, medical or lifestyle procedures are not in place. As far as phenethyl isothiocyanate is concerned, while it has been clinically shown to offer potent anti-inflammatory and chemo-preventative actions against colon, prostate, breast, cervical, ovarian, pancreatic and other cancers, high dose trials on rats and dogs showed no observed adverse effects.

Lastly, lightly steamed or fermented are the best ways to enjoy cabbage. While fibre-related compounds in raw cabbage have the ability to bind with bile acids in the digestive tract, this effect is much enhanced in lightly steamed, sautéed, or fermented cabbage, and reduced in over-cooked cabbage. This is important because excess bile is implicated not only in colon cancers, but in elevated cholesterol levels too, and fibre-bound bile acid is easily eliminated from the body. Overcooking of cabbage is something to be avoided for other reasons too – destruction of the myrosinase enzyme occurs during the heating process, and as we have seen that many of the health benefits of cruciferous vegetables rely on the products of the myrosinase/glucosinolate reactions, we want to avoid that boiled to death cabbage that nobody loves anyway if we can possibly help it.

Now we are agreed that cabbages are an awesome, healthy and healing food, we will take a look at how they are augmented by our helpful probiotic allies during the process of fermentation.

Cabbage contains appreciable levels of carbohydrates, crude fibres, proteins, lipids, and ash. The first and foremost effect of fermentation is that the carbohydrates are converted to lactic and acetic acids at the ratio of near enough 4:1 (and to a lesser extent succinic, malic, and propionic acids), carbon dioxide, ethyl alcohol, mannitol and dextrans. The total carbohydrate content is reduced by more than 80% in the finished product, with the sugars glucose, fructose, and sucrose being reduced by about 66%. The various components of the lipid fraction, though small, are metabolised to yield free fatty acids, glycerol, phosphates and free choline.

Digestive enzymes, vitamins, amino acids, glucosinolates, and antioxidant powerhouses (such as glucosinolate metabolites, superoxide dismustase and glutathione) are produced during the sauerkraut fermentation. The free-radical scavenging capacity of β-carotene, ascorbate, and α-tocophorol (fundamentally vitamins A, C and E) remains intact in the finished kraut, and there is evidence that these (and we may assume other) antioxidants work synegistically together. The fermentation process produces vitamins B3 and B6, and converts vitamin K1 to K2 (which often does not happen in a compromised gut), making fermented products a good source of K2 for those who don't eat animal products. Bioavailable vitamin B12 is also produced by fermenting cabbage, and since vitamins K2 and B12 are so important, and in such short supply in modern (especially vegetarian or vegan) diets, we will consider each of these in turn.

Vitamin B12

There was a study in 1991 suggesting that B12 from fermented plant foods, nori and spirulina was not bioavailable. That study was flawed in many ways, including the fact that the only plant based fermented food tested was sourdough bread. The sample size was small (11 children), and variables with the potential to skew data were not adequately controlled in my opinion. With a healthy gut, our intestinal bacteria produce B12, but it largely can't be taken up because B12 needs to be joined first with the IF (intrinsic factor) protein in the duodenum (upper small intestine) to be absorbed. The co-joined but not bound B12 and IF are broken down somewhat by pancreatic enzymes as they pass through the duodenum, allowing them to bind together and be transported across the lumen of the ileum (distal, or lower small intestine).

Bacterially produced B12 from selected fermented foods (e.g. sauerkraut, gundruk, natto, tempeh) is, in my opinion, one reliable source of bioavailable B12 for anyone who doesn't eat animal flesh or products. I would also suspect upon perusal of the available literature that unfermented nori seaweed contains bioavailable B12, but not spirulina, and there is some evidence that B12-like substances in certain plant foods may be preferrentially absobed by the ileum, and so block true B12 uptake. A study of Korean centenarians who consumed a predominantly plant-based diet revealed that their B12 status was near enough identical to Western centenarians who consumed large amounts of high B12-bearing animal foods, and the researchers concluded this was most likely the result of the high B12 content they found upon testing of traditional Korean fermented foods. Some Korean fermented foods contain fish sauce, a fermented animal product, but there is not agreement upon whether fish sauce contains bioavailable B12. No matter what the food source, vitamin B12 may be absorbed variably depending on many factors, some of which are advanced age, *Helicobacter pylori* overgrowth, and lack of balance and optimal health in the body, especially dysfunction or dysbiosis in the gastro-intestinal tract.

Vitamin B12 (scientific name cobalamin) is essential for health and life, being involved as it is in virtually every process in the body. It is essential for DNA synthesis, blood cell formation, nerve sheath synthesis, protein synthesis, and cellular metabolism of lipids, carbohydrates and proteins. Cobalamin enters our body attached to proteins in our food, from which it is seperated by our gastric hydrochloric acid. Free cobalamin then attaches to a protein called R protein and passes into the duodenum, where it is set free again so it may attach to the aforementioned intrinsic factor, and thence be transported to the ileum, where the IF/B12 complex can be absorbed and utilised, providing there is adequate calcium present. Sauerkraut is a good source of bioavailable calcium.

Research on B12 availability is contradictory, and while I feel fermented foods offer bioavailable B12, vegans may want to consider supplementation.

Vitamin K2

The K in vitamin K stands for 'koagulation', the German word for blood clotting, and this is the connection most of us make with vitamin K. The reason newborn babies are often given a K1 shot (vitamin K has three main forms – K1, K2, and K3) is the inability of the vitamin to cross the placenta means the infant has no stores of vitamin K to combat haemorage. Four of the twelve proteins necessary for effective blood clotting are almost certainly reliant on vitamin K for their formation, yet babies have been birthed for thousands of years without K1 shots. K1 is extremely cheap to produce synthetically, unlike the prohibitively costly K2, and cynics may declare a K1 shot for every newborn baby is quite the money spinner. Proponents of K1 shots for newborns will argue that it is a harmless intervention that may (very rarely, in the event of major internal or external haemorrage of the newborn) save a child's life. Like every procedure or contact in a hospital where the occurrence of antibiotic-resistant superbugs is best assumed, injections offer a route for infection. As in all things relating to our children, this a decision for

informed parents to make on their own, bearing in mind that once fed, baby has adequate vitamin K anywhere from 3 to 21 days afterr birth. Antibiotic treatment of carrying mother or new-born (and subsequent gut dysbiosis), or liver dysfunction in the child or breast-feeding mother will interfere with the natural acquisition of vitamin K from the diet, so a vitamin K shot is certainly more advisable in these scenarios. Much more important, generally speaking, is maintaining a diet high in vitamin K during pregnancy (and before, if conception is a planned event), because deficiency of this vitamin has been implicated in birth and developmental defects such as heart dysfunction, cranial and facial deformation, neural tube defects, microcephaly, abnormal growth patterns, and learning disorders.

The most abundant form of vitamin K in the diet is K1, and we are interested in K1 here predominantly because both it and K3 are required to produce the various forms of the more effective K2 in the body, and K1 is necessary for K2 production in the fermenting vessel. K1 is abundant in fresh, green leafy vegetables such as cabbage, not surprisingly because it is essential for photosynthesis. K3 is found in trace amounts in foods, not a lot is known about it, except that it seems it can be produced from K1 in the gut as well. Most nutritionists and dieticians will tell you that K1 and K3 deficiency is not an issue they often encounter (you would even be doing well to find someone to tell you the function of K3 in the body). Vitamin K2, however, is a different story, because though it can be formed in the healthy gut, how many of us are the lucky owners of a perfectly balanced digestive tract?

Plant foods do not contain much in the way of preformed K2, unless they have been fermented, in which case, they are good sources of K2 indeed. The K2 vitamins (there are a few varieties) are defined by the number of repeating phenyl units they trail. MK-4 (the 'M' is for menaquinone, the chemical name of K2, and 'K' is for the common name) has 4 phenyl units, MK-7 has 7. While both vitamins K1 and K2 are involved in regulating bone mineralisation and demineralisation, research indicates that the MK-4 and MK-7 forms of K2 are the most important. Different fermented foods are good sources of the

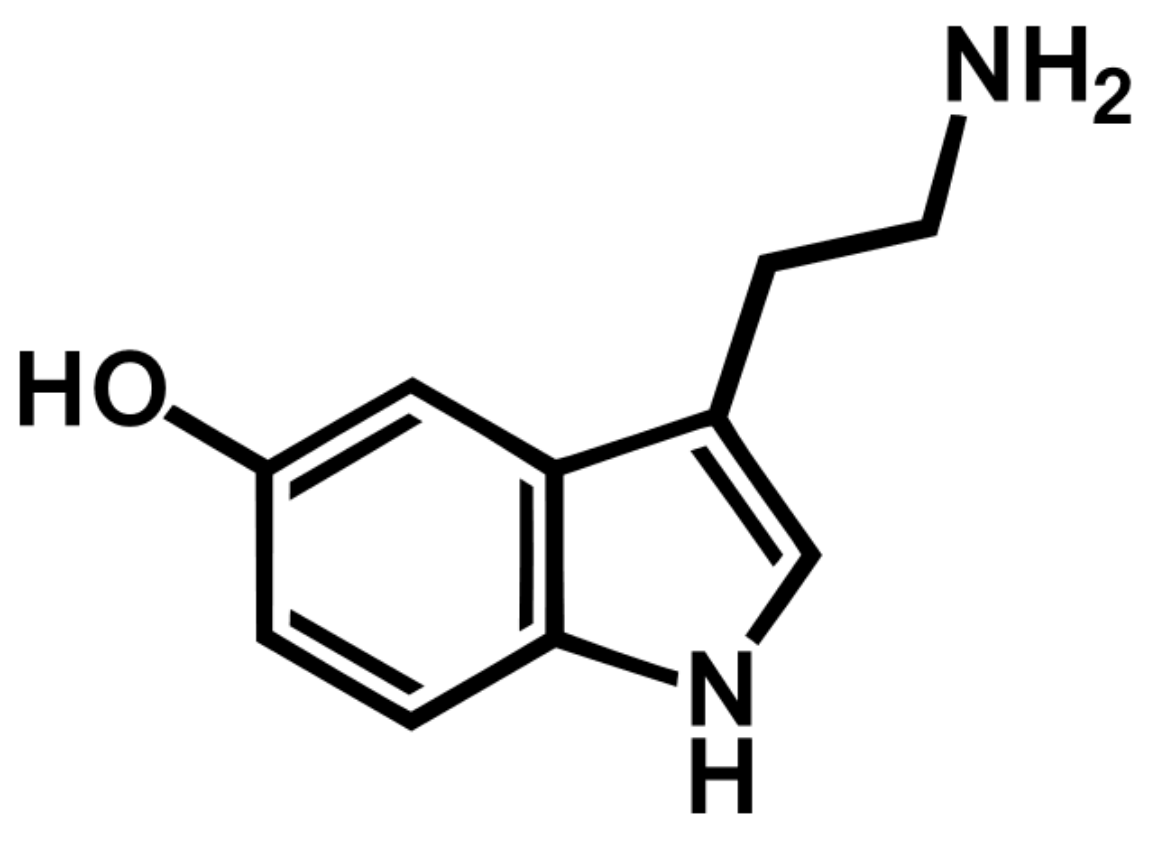
different subtypes – natto and other fermented soy products are high in MK-7, while sauerkraut and other green ferments such as gundruk are high in MK-4. While K1 is abundant, only about 5-10% of ingested K1 reaches the blood stream, where it lasts for but a few hours. K2, though less abundant, lasts several days in the body, and close to 100% of dietary K2 is absorbed by our gut. Before we look at the K2 specific benefits, the quick take home message is eat fresh greens daily to be well supplied with K1, and learn which foods contain the more effective K2 and add these to your diet at least three times a week. Vitamin K2 is also stored in the organs, meat, and milk of animals, but this applies only to grass fed animals. Recall the K2 lasts but a few days in the body, so grain-fed or grain-finished animals will not supply us with K2 via their flesh or milk.

Bacteria, neurotransmitters, and mental health

"How (these) differences in our microbial world influence the development of brain and behavior will be one of the great frontiers of clinical neuroscience in the next decade." - Thomas Insel, Director of the (US) National Institute of Mental Health

Many strains of probiotic bacteria have been found to produce the same compounds we use in the body to regulate neural function and mood – things like serotonin, dopamine, and gamma-aminobutyric acid (GABA) – and this production works to not only maintain normal gut function, but to regulate mood as well, postulating a gut/brain axis. Serotonin is important in the regulation of many bodily functions, including mood. Strains of *Bifidobacterium, Streptococcus, Enterococcus,* and *Escherichia* have been found to produce serotonin, with *Bifidobacterium infantis* also producing tryptophan, the amino acid precursor to serotonin. *Bifidobacterium* and *Lactobacillus* produce GABA (the body's main neural relaxant) from glutamate, one *Lactobacillus* strain has been identified as a producer of the

neurotransmitter acetylcholine, *Bacillus, Esherichia* and *Saccharomyces* produce norepinephrine, while *Bacillus* and *Serratia* produce dopamine.



The serotonin molecule

The most likely route for communication between substances produced in the gut and the brain (as indicated in the literature) is the vagus nerve, which directly connects the two. One mechanism proposed for this (rather than the disputed concept of dietary sources of substances such as GABA being able to cross the blood brain barrier) is that the vagus nerve signals to the brain that these neurotransmitters are in the body, and the brain either acts as if they were within it (rather than in the gut), or is prompted to produce the substance itself. Other proposed communication routes of the gut/brain axis are the spinal cord, and the neuroendocrine system. The positive results of probiotic therapy and restoration of gut health in areas of mental health as

diverse as interferon-induced depression, obsessive-compulsive disorder, and post-traumatic stress disorder are being reported not only in scientific literature, but anecdotally from doctors and their patients. So much so that terms like 'psychobiotics' and 'psychoneuroimmunology' are frequently encountered in journal articles, and even in the mainstream press.

How does this work? Well, it's early days, but as with most human dysfunction, it appears to come down to our old friends gut dysbiosis and inappropriate bodily inflammation (dysbiosis is defined as a microbial imbalance that detrimentally impacts on normal function). Lipopolysaccharides (LPS) function in the body as endotoxins, and are produced by many gram-negative bacterial pathogens. LPS is used to create a depressive state model in rodents for clinical studies. Mice engineered to lack a cytokine responsible for mediating inflammatory response are resistant to the artificial depressed state induced by LPS, which indicates the role of inflammation in the regulation of mood. Western diets tend to promote inflammation and elevated LPS levels, whereas studies on traditional or ancestral diets that utilise fermented foods show elevated antioxidant and anti-inflammatory activity in the body, concomitant with reductions in gut wall permeability and LPS levels. Fermented foods (including the live organisms contained therein) also enable production of essential enzymes, vitamins, neurotransmitters and neuropeptides, modulate function of the adrenal cortex toward a relaxed bodily state, confer improved glycemic control and cholesterol management within the body, produce GABA and other beneficial bioactive compounds directly, and help restore optimal balance within the microbiota, all of which have positive effects on our mental state.

Making sauerkraut

We will be making some basic sauerkrauts in the workshop, and as I consider sauerkraut to be the best all-round fermented food there is, there follows a lengthy discussion on the process. Read the material at your leisure after the workshop, there is other information there, and there are recipes for different kinds of cabbage ferments at the end.

Before we look at what goes on in a crock or jar of fermenting cabbage, let's address the two most common areas of concern – salt, and potential food poisoning. Firstly, even though sauerkraut tastes acidic, the salt we add has not disappeared – the level of salt we begin with is the level of salt we finish with. So, use a good quality salt, and account for it in any calculations you make if you follow a sodium-reduced diet. Secondly, the acidic environment of properly fermented sauerkraut actively excludes pathogens such as *Clostridium botulinium*. Remember earlier when we discussed ecosystem parameters? Here is a good example – we create an environment that favours the microorganisms we want, while at the same time, excluding the undesirable species. If we start well, we finish well – or to paraphrase Mary Poppins: well begun is halfway done.

The perfect cabbage

We begin creating the environment for the production of the perfect sauerkraut (literally 'sour cabbage') when we choose our cabbage. The perfect cabbage is a large, dense, mature head of white cabbage (*Brassica oleracea var. capitata* for*. alba L.*), it is as fresh as possible, it is local, and it is organic, biodynamic or chemical free. Of course other varieties of cabbage are perfectly acceptable, in fact I recommend fermenting as many varieties as you can, as long as they are likewise organic. Why is organic cabbage important? Many of the organisms that will initiate fermentation already exist amongst

the leaves of our cabbage, and these may be compromised by chemical applications. Chemical residue on foliage may likewise kill desirable organisms, and inhibit or prevent proper fermentation, but there are far more deleterious effects of the chemicals applied to our food than merely making them problematic to ferment.

The problem with agricultural chemicals

One chemical that is almost universally used and assumed to be safe when multiple studies show that it is far from safe is glyphosate. Glyphosate (C_3 H_8 NO_5 P), the key ingredient in 'Roundup' and similar herbicides, is a broad-spectrum metal chelator that works by binding (inactivating) the micro and macronutrient co-factors calcium (Ca), cobalt (Co), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), nickel (Ni), and zinc (Zn) essential for plant enzyme activity. While most chelators have an affinity for one or two metals only, glyphosate's wider range has established it as the most commonly used broad-spectrum herbicide in the world. This action also makes glyphosate a potent broad-spectrum antibiotic as well, since enzymes essential for microbiol survival are also affected.

Contrary to popular belief, glyphosate is not biodegradable in the commonly accepted sense of the word. Degradation is slow to non-existent, mostly mediated by microbiol co-metabolism when it does occur. This residual nature may in fact be a blessing, since most breakdown products of glyphosate are toxic to both conventional and 'Roundup ready' plants (plants genetically modified to be resistant to glyphosate so they can be managed via massive applications of the herbicide). Glyphosate accumulates in all plant meristematic tissues (root and shoot tips, reproductive sites, and legume nodules), and translocates to the rhizoshpere (soil surrounding the roots) easily through roots, rootlets, nodules, and mineralisation of fallen treated above ground plant tissues. Glyphosate can be immobolised in soils via chelation with certain cations, but application of phosphate fertilisers works to

desorb accumulated chemical from soil colloids, thus compromising the ability of subsequent crops to thrive, and to take up and store vital nutrients. Mobilised glyphosate, however, is easily taken up by the roots of all plants, where it accumulates, and enters the human food chain.

The scientifically observed or indicated effects of glyphosate on soil, plant, and human health (as noted in numerous peer-reviewed studies) include: toxicity to soil micro-organisms that enable nutrient availability and absorption in all plants; stimulates pathogenic micro-organisms that inhibit nutrient availability; inhibits nitrogen fixation; damages soil structure; reduces photosynthetic potential via inhibition of pyrrole synthesis; increases mycotoxin occurrence in stem, straw, grain, and fruit; induces fruit and bud drop; reduces both concentration and bioavailability of Ca, Cu, Fe, K (potassium), Mg, Mn, and Zn in plant tissues and seeds; reduces plant biomass and yield; decreases plant resistance to drought and disease; bioaccumulates in plant and animal tissue (including human tissue, and the meat and milk of the animals we consume); chelates aluminium (Al) in the gut, facilitating absoption and transport of Al in the body (Al is also a key ingredient in the 'Roundup' formula); works synergistically with Al to induce pineal gland dysfunction; disrupts cytochrome P450 enzyme leading to reduced melatonin production; blocks synthesis of trytophan (essential for both melatonin and seratonin production) in plants and micro-organisms; preferentially kills beneficial bacteria leading to gut disbiosis, and subsequent *Clostridium difficile* and *Candida albicans* proliferation and overgrowth (and *C. difficile* produces the toxic phenol p-cresol, which enhances Al uptake at the cellular level, and which is implicated in autism in both human and animal models) ; reduces production of APS and PAPS enzymes essential for sulfate activation and metabolism, thus preventing formation of important molecules such as amino acids, and the glucosinolates in cruciferous vegetables; unmetabolised dietary sulfate utilised by *Desulfovibrio* sp., and converted to highly toxic hydrogen sulfide gas in the gut; multiple routes of impairment to CYP enzyme function predisposing to liver toxicity, resulting in impaired ability to metabolise drugs and toxins, potentially leading to hepatic encephalopathy; induces both haemoglobin and B12 deficiency anemias via reduced pyrrole synthesis; induces anemia via reduced

uptake of iron and cobalt in food plants; contributes (probably substantially) to D3 deficiency via compromised mitochondrial and microsomal CYP enzymes in the liver and kidney responsible for the first and second steps respectively of vit D activation; contributes to carcinogenesis; and, finally (rather than going on and on because I think we get the idea), crosses the placental barrier and has been found in human breast milk.

This is but a small sampling of the detrimental effects of one chemical only, just imagining the combined effects of all agricultural chemicals should be enough to convince most of us that chemical free food is best. In the second of two recent papers examining the toxilogical effects of common herbicides and insecticides, the authors concluded that despite its reputation for safety, 'Roundup' was the most toxic of all the pesticides studied. This was largely due to the synergistic effect of the different ingredients in the Roundup formula. For example, surfecants such as polyethoxylated alkylamines, whilst being extremely toxic on their own, worked synergistically with glyphosate to increase glyphosate toxicity an estimated 125-fold. If that isn't enough, consider the interactions of agricultural chemicals with all the other environmental toxins we are subjected to. We can change food production values easily with the power of our wallets – merely refusing to buy genetically modified and chemically treated foods will eventually force a switch to cleaner, more ethical, and more environmentally sound and sustainable farming practices. We owe our children that much, at the very least.

Salt

And so, with our perfect cabbage procured, we turn to the only other ingredient we truly need – sodium chloride. This helpful little compound doesn’t mind if we just call it salt, it is, after all, the original 'salt of the earth'. Neither does it mind if it shares the stage with other players (and we shall meet some of these later), but for now, let’s call salt to the spotlight.

Salt at its most basic is sodium chloride, though most good salts contain additional valuable minerals, and we should consider this when we choose our salt. Those minerals are essential for optimal bodily sodium levels, and many good salts also contain iodine in a natural form that is well assimilated by the body. Sodium is found in every fluid in the body, where it is an essential contributor to a host of biochemical processes. Some major roles for sodium include: regulation of the acid/alkali and water balances within the body; influencing fluid distribution across cell membranes; and maintenance of normal adrenal, nerve and muscle function. It is no secret that as a society we consume too much salt, and excess sodium is implicated in high blood pressure, in heart, kidney and liver disease, and in potassium deficiency. We don't want to eat too little salt though, because salt is our main dietary source of chloride, another essential mineral.

Chloride exists as a minor trace element only in the typical diet, the most reliable source being salt added to our food. Like sodium, chloride also helps regulate the acid/alkali balance within the body, and the passage of fluids and their solutes across cell membranes. Chloride is also important for the normal growth and function of the brain. We could not digest protein without hydrochloric acid, and chloride also stimulates production of the enzymes required for carbohydrate digestion. So it begins to become apparent that there are very good reasons why we have traditionally added salt to foods – not only do we need sodium and chloride in the body, we need chloride to help us digest our food.

So, even after the briefest of acquaintances with sodium and chloride we discover that salt is no villain. Rather, we have an essential ingredient to a balanced modern diet that we have elevated to villain status through over use. Most of this over usage is hidden in the small print on the labels of processed foods, but as we move away from food-like products and return to the joys of real food, we find we are in a position to know and control the amount of salt we use.

The amount of sodium chloride added to our cabbage not only influences the formation of anaerobic conditions via provision of a selective bias toward desirable bacterial growth; taste, texture and aroma of the final product, and the time taken to ferment to ripeness are also affected by our initial salt concentration. Remembering that the salt goes nowhere, I ferment my sauerkraut at the low end of the salt scale for many reasons, one of which is freeing up a part of my overall sodium budget for the more heavily salted ferments I enjoy, and for the addition of salt as an essential taste enhancer in cooked foods. The average salt to cabbage ratio for finished sauerkraut in the US is 16.7 g/kg, while German production averages at 11.3 g/kg. In my sauerkraut production I use 11 g/kg at the onset, and since the mass of the cabbage is reduced slightly during fermentation, my finished kraut will be fairly close to the German average. I arrived at my ratio through years of experimentation, and only later found in my research that this ratio followed so closely the norm of production in the country we generally think of when we think of sauerkraut.

The cabbage and the salt are combined to create the substrate. Substrate is merely a fancy word for the food source which will be transformed by our helpful little friends and fellow travellers during the fermentation process. The sauerkraut substrate includes the brine – water drawn from the cabbage by the salt, and combined with it. So we have shredded cabbage, and salty water, and what happens next is entirely dependent on how well we have set those ecosystem parameters. Taking cleanliness, pure salt, and a good, fresh, organic cabbage as givens, this boils down to nothing more than the percentage of our salt solution, and to how well we exclude oxygen. Later we will look at an easy rule of thumb for getting our desired salt concentration based on dry vegetable weight (including a very simple equation for uneven weight values), and also at strategies for excluding oxygen, but for now, we turn our spotlight to just how lactobacillic fermentation of vegetables works. It is here that our cast, and our food, truly come to life.

Lactobacillic fermentation of cabbage

Food technicians use the term "home flora" to describe the first life we must consider. This term describes the microorganisms that exist not only on our perfect cabbage, but also on us, on our equipment, and in the air around us. Some of this life is crucial to initiate the microbial succession of a successful ferment, but other members of this cast more often elicit boos and hisses rather than cheers and applause – characters such as salmonella, clostridia, listeriae, and stock villains like *E. coli* are fairly omni-present, and in all probability find their way into every batch of sauerkraut we make (not to mention every other thing we eat). And yet, most of us have never experienced a serious or life threatening bout of food poisoning, and many of us have never known it at all. In his book *The Art of* Fermentation, Sandor Katz quotes Fred Breidt, a microbiologist for the US Department of Agriculture specialising in vegetable ferments: "As far as I know, there has never been a documented case of food-borne illness from fermented vegetables." How can that be when the agents of food spoilage and sickness are all around us? Yep, you guessed it – it's those ecosystem parameters again. Conditions have to be just right for the agents of food poisoning to achieve a population large enough to harm us, and what we are doing by salting our cabbage is making conditions right for the organisms which will in turn modify the environment to suit our desired climax community of lactobacillic bacteria. In effect, we are initiating a kind of controlled food spoilage, where the natural tendency of living tissue that is disconnected from the life source to rot and decay is directed instead down the road of preservation and augmentation.

Lactobacillic bacteria are classified as either homofermenters, or heterofermenters. Homofermentative lactic acid bacteria species (LAB for short) produce predominantly lactic acid, while heterofermentative LAB species produce half as much lactic acid as well as CO_2, acetic acid, and other volatile compounds (including traces of ethanol), so logic may suggest we court the homofermenters to speed things up? We could do this by using a > 3% salt concentration, which favours certain homofermentative species, but

experience shows time and time again that rapid fermentation results in sauerkraut with a bland, unbalanced taste, often with in a limp and slimy texture. So, how low can we go? If we set our salt parameter too low (< 0.8%) we are inviting dominance by less than desirable bacteria, and our sauerkraut will be of an inferior quality – bland and soft. Nobody wants that! I use salt concentrations (brine strength) within the range of 1.5 - 2.5%, with the high end being reserved for hot summer conditions and the low end for the winter. High temperatures facilitate increased acid production, so fermentation is rapid, but the taste is shallow and immature. More salt slows the desired fermentation rate, and less salt allows it to proceed more rapidly. Once the ambient temperature strays outside the optimal 15 - 20° C (the temperature inside the crock can be one to three degrees higher), we may think about adjusting our salt concentration to compensate. So, a lot of salt will slow fermentation, until we exceed 3% (3 g salt/100 ml water), when fermentation appears to proceed more rapidly due to by-passing the first two stages of fermentation, and facilitating the increased lactic acid production of homofermentative tertiary species.

When we have lovingly created our environment, the first stage of our fermentation is activity by enterobacteria. These facultative anaerobes begin feeding, rapidly using up any remaining oxygen within the fermenting vessel. The result is an increasingly anaerobic environment with a decreasing pH, due to the formation of lactic, acetic, succinic, and formic acids. Some authors don't count this as part of the fermentation process, and deny any contribution by these organisms and their metabolites to the taste and texture of the finished product, but I disagree. I see this is an important stage that when by-passed by sub-optimal salt concentration and/or the addition of a starter culture containing later successional LAB species, results in an inferior product in all aspects (taste, texture, and systemic benefit). Many starter cultures are developed using only two key species (*Lactobacillus plantarum* and *Leuconostoc mesenteroides*), with the aim of reducing fermentation time by 14 days or so, and with a benchmark of one million colony forming units (CFU) of bacteria per gram of product (to qualify as a functional probiotic food). Wild fermented sauerkraut, on the other hand, can contain as many as

forty billion CFU per gram, with much higher species diversity. Diversity is important, because most often we find that the combined action of probiotic bacteria is greater than the sum of their individual actions alone. There is also, during the early stages of fermentation, a minor contribution by yeasts to the development of flavour, though the population of yeasts rapidly declines with the changing environment.

This modification of the environment is fairly rapid, and the second stage can be expected to commence within 1 – 3 days, when heterofermentative *Lueconostoc mesenteroides* (and other species) already present become favoured. Increased acidity (lowered pH) due to rapid production of lactic and acetic acids by *Lueconostoc* and allied bacteria results in a favoured environment for more acid-tolerant species such as *Lactobacillus brevis*, and the increasingly anaerobic conditions due to CO_2 production favours the stabilisation of vitamin C (ascorbic and dehydroascorbic acids). By day 3 – 6 (depending on ambient temperature), lactic acid concentrations have risen by about 1%, and this stage of fermentation is complete, leaving a modified environment suited to the needs of bacteria capable of homofermentation at the lowered pH.

Lactobacillus plantarum, *L. sakei* and *L. Curvatus* are the most important of the players at this third stage of fermentation, but by no means the only ones. It is during this stage that the majority of available sugar (glucose, fructose and sucrose) is converted to organic acids (predominantly lactic acid), and the acid concentration rises to 1.5 – 2%. The pH at the end this stage may be expected to be in the range of 3.8 – 4.1. Most commercial sauerkraut production is halted here as a concession to modern tastes for less acidic (sour) foods, and for lesser salt concentrations per gram of product. As mentioned earlier, the salt does not disappear (or even multiply), but as the total mass of plant matter is reduced due to the action of fermentation, the functional salt concentration increases slightly.

In the final stage of fermentation, heterofermentative species dominated by *Lactobacillus brevis* become active once more, metabolising complex pentose sugars like xylose and arabinose. Acid concentration can be expected to rise to 2.5%, and pH to fall as low as 3.4. I always endeavour to ferment my sauerkraut to this stage, while at the same time, eating a little from each stage of fermentation. I enjoy, as Sandor Katz mentions in his book *Wild Fermentation*, sampling the evolving taste of the kraut, but I believe there are also sound functional reasons for this practice, which are discussed in my gut repopulation ebook.

Before we move on to making sauerkraut (possible to the cry of "it's about time!"), there is one important matter to consider regarding when to halt the fermentation. If sauerkraut is to be utilised as a fresh and unpasteurised vital food (as I hope it is), it is important that all of the available sugars be metabolised, otherwise, we may reawaken the yeasts every time we open the jar, who may instigate a low key sugar to alcohol fermentation. This also entails a reduction in the quality of the taste of the kraut, so while the idea of sauerkraut wine might be intriguing, there are much better alcoholic ferments available to us. If the kraut is to be canned or heat treated in any way, fermentation may safely be halted after the third stage is complete.

The first function of the salt after addition and massaging/pounding it into the shredded cabbage is to draw moisture from the plant material, and so create our all-important brine. The second function is to control and direct fermentation by favouring some organisms over others, as we have seen. The most efficient way of doing this is to maximise surface area, so even though the preferred size of the shredded cabbage is a personal thing, most sources recommend a width of around 0.8 – 2 mm. I have also found that the sweetest kraut often comes from the finest shred. The function of the massaging or pounding is to "bruise" the leaves, opening them up to the salt, which may then draw the water for our brine more efficiently. Though I often don't weigh my cabbage and salt because I have a good idea of how much salt to add to

how much cabbage by eye and taste, I do weigh them every now and then to ensure I am calibrated correctly. The best way to get the desired concentration is to weigh the shredded cabbage, and then weigh the salt. Because cabbage is "self-brining", the exact concentration of the brine will be to some extent determined by the moisture level of the leaves, but a good rule of thumb is one teaspoon of fine salt per 500 g or 1 lb of shredded cabbage. A pound is 453.5 g, and a teaspoon of salt is somewhere between 5 – 6 g (depending on the variety). In general though, 1 teaspoon of salt to the pound or half kilo will give a brine of close enough to 2%. Fine tuning of the process comes with experience, but if you stick by this general rule of thumb initially, all will be well. I work in metric, and for every 500 g of cabbage, I generally add 5.5 g of salt (11 g salt/kg of cabbage). Adjust the salt up or down for taste and temperature when you feel confident, remembering to be neither too light, nor too heavy handed.

Salting may be done in a big bowl, and the salted cabbage transferred to a fermenting vessel, or it can be done as we go if we are laying the cabbage down in a crock or other large vessel. If fermenting in a Mason or similar jar, it's best to salt and massage/pound well first, then pack the salted cabbage tightly into the jar, using something like a wooden spoon, rolling pin or purpose made kraut pounder to tightly compress the material. Or you can use your hands as I do. As mentioned above, when using the crock method, we can layer the cabbage, and add salt to each layer as we go. Cover the bottom with the shredded leaves, sprinkle a little salt over them, then use whatever method you prefer to pound and compact the matter. I find it satisfying to use my fist, getting into a rhythm, and getting up close and personal with the materials. This is the time, when I am in prolonged and intimate contact with the food, that I like to enter a meditative state and put the energy of love into the food. I thank the earth for the salt and the cabbage; I offer respect and gratitude to the life I will be utilising to sustain me and my family; I invite, praise, and thank the microorganisms of beneficial transformation; and I think of the love I have for all who will eat my produce.

All free air (or as much as possible) should be removed from between the leaves. Take time over this, it's important to establish near anaerobic conditions right from the outset. As we compact the cabbage, enough brine should be expressed to cover the leaves by the time we are done. If this is your first sauerkraut (congratulations!), prepare to be surprised by just how much liquid comes out of the cabbage when it is given a good love pounding. Sometimes, if the cabbage is a little dry, or if the shred is a little coarse, we may find we don't have enough brine. We can remedy that simply enough however by mixing a small amount of brine. For every cup (250 ml) of water, simply add 5 g of salt and mix well for a 2% brine. Use this brine to top up your crock or jar, remembering to leave some headspace because the substrate will expand in the initial stages of fermentation.

Why does it expand? Remember the carbon dioxide (CO_2) we discussed as a fermentation by-product? Elements combined as solids take up less room than elements combined as gasses, and while we want a system that burps the excess CO_2, it takes a while for the initial first flush of gas production to work its way out of the tightly packed cabbage. This causes the entire mass to increase in size, and failure to leave adequate headspace will result in overflow and spillage. For a 750 – 1000 ml jar, 35 – 40 ml (about an inch and a half) is what I would consider good headspace. For a crock, I like a minimum of 50 ml (2 inches) of headspace from the top of the weights. Talk of headspace and weights brings us quite nicely to why we keep the cabbage beneath the brine, so let's go there now.

We keep the cabbage beneath the brine, and in a closed system because we are engaged in a process of anaerobic fermentation. Unaccompanied oxygen has no invitation to this party I'm afraid, because its presence will favour the formation of kahm yeast and/or mould. Kahm yeast is a benign colony of yeasts whose specific components vary with locality and ambient conditions. They may first form a light mist or collection of small rod-like structures on the surface, but will eventually form a mat of highly textured, intertwined thread-like structures. This will be pale in colour, most usually whitish, but will

become coloured by the liquid of the substrate. If you are making beet kvass, your kahm yeast may well be pink. Kahm yeast is benign – it's not toxic or harmful in any way I have discovered, but it does impart a fairly rank taste to the ferment. It can be removed, we'll discuss that later in the troubleshooting section, but it generally returns. So, kahm yeast – all in all harmless, but best avoided; unlike mould, which is potentially harmful, and in my opinion must be avoided at all costs.

Mould is so important we consider it at length elsewhere, but for now, a quick overview. Mould can be white, black, grey, yellow, green, blue or brown, but by the time we notice it, there is a defining feature – mould is fuzzy. Unfortunately, we cannot assess the safety or otherwise of mould based solely on colour, and many species may present as any one of a number of possible colours. If you see something on your ferment and it's not fuzzy, it's most likely kahm yeast, not mould, though mould may first be noticed as a fine whitish mist on the surface. By the time I have a positive mould identification in a ferment, I consider that ferment compromised beyond redemption – this is one of the few areas in life where I draw a hard line. This is contrary to received wisdom on the subject, yet my advice is no more right or wrong than any other; merely a response to my own research findings coupled with a tendency to err on the side of caution where my family's health is concerned. Happily we can exclude both mould and kahm yeast by excluding oxygen and preserving a headspace of CO_2 that can off-gas (burp) under pressure.

So in packing away our ferment, we first want to ensure that all the vegetable matter is below the surface of the brine. Cabbage exposed to the air will oxidise and turn brown. This isn't harmful, but the taste and texture of oxidised cabbage is dreadful so we seek to avoid this. Mould is also more likely to form on exposed vegetable matter. When all the cabbage is packed down, it is good practice to create an initial barrier by laying down a cap composed of a couple of layers of the washed whole outer cabbage leaves for a crock ferment, and a rolled up cabbage leaf plug for a jar ferment. On top of this we will need a weight of some food and acid safe material, such as glass or ceramic, to

prevent the cabbage from floating above the brine, and ideally the brine will be sufficient to cover the weight as well. After that, we merely exclude oxygen and allow for off gassing, but how we approach this will depend on the type of fermenting vessel we are using. Please refer to the chapter on equipment for details on common fermenting vessels, and for strategies for keeping vegetables beneath the brine.

Once our ferment is set, we want to leave it alone for six weeks minimum. Place the jar or crock somewhere where it is out of direct light, and where it will most closely be maintained at the ideal temperature of 15 – 20° C. Try to avoid temperatures outside the range of 10 – 28° C. Stand jars in a bowl of water if the temperature is too warm, and cover crocks with damp towels. Place old jumpers or insulating jackets over jars or crocks to keep them warm, or invest in a heating pad, easily sourced from home brewing shops.

Recipes

Now that we exhaustively gone through sauerkraut, and we all have a good understanding of what is involved, what happens, and what we should expect, it is probably a good idea to provide a recipe type format. We will start with the basic unadorned kraut as described above, and then variations and suggestions will follow, all based on 1 kg of shredded cabbage.

Basic Sauerkraut

1000 g of shredded, white cabbage

11 g of salt

Shred the cabbage to the preferred size, add to a large bowl, and then add the salt. Massage the salt in well, rubbing and wringing and squeezing the cabbage to break down the cell walls. The salt will draw out the moisture of the cabbage as we 'bruise' it, and open it up. When we can pick up a handful of cabbage and squeeze it so a good stream of moisture is expressed, we have massaged enough. Don't forget to put love in the food as you work if the thought of energetically enhanced food appeals to you.

Pack the cabbage down into your fermenting vessel as tightly as you can. Use your hands or a tool – purpose-built kraut pounders can be purchased or made (often out of an old rolling pin with one end cut off and sanded smooth). Wooden spoons or sanded dowel rods may also be used. Express all the air out of the cabbage as you pack. We want no air bubbles at all if we can help it. Leave enough room in the jar to allow for expansion of the cabbage, 35 – 40 ml (about an inch and a half) for a jar, 50 ml (2 inches) for a crock. Ideally the headspace is measured from the top of your weight, which is covered by brine. Use the outer cabbage leaves as a cap, whole leaves layered in a crock, rolled up leaves for a jar. Top this with your food safe weight, best materials are glass or ceramic (no external paint or metallic leaf), but food safe hardwoods and boiled and scrubbed smooth, hard, non-porous river stones are also used. Do not use metal or plastic please – the metal will corrode in the acid, and the plastic will leach toxins and oestrogen-like compounds into your food (yes, even 'food safe' plastics). Place the lid on your fermenting vessel, then put in a safe place for six weeks. Consult the sections above, and the equipment section for more detail on procedure and fermenting vessels.

If you have more or less cabbage than 1000 kg, use the simple calculation below to adjust the salt, we will assume the difference is 200 g, adjust to your circumstances.

200 g ÷ 91 = 2.2 g

If you have 800 g of cabbage, subtract 2.2 g of salt to give you 8.8 g, if you have 1200 g of cabbage, you will have 11 + 2.2 g of salt, or 13.2 g. This equation is found by dividing the cabbage by the salt to arrive at the factor. This factor is then applied to the cabbage to determine the salt. So, 1000 g ÷ 11 g = 90.9 (round up to 91). Our factor is 91, test this by dividing the cabbage with it: 1000 g ÷ 91 = 10.9 g (round up to 11).

Any odd weight of cabbage may be likewise divided by our factor to find the salt in grams. For example: 562 g ÷ 91 = 6.2 g. Or 3675 g ÷ 91 = 40 g. Now that little bit of painless mathematics is out of the way, and we are armed with the ability to accurately determine the salt to add to any amount of cabbage, let's look at some variations based on 1 kg of cabbage and 11 g of salt. The amounts given produce a mild tasting kraut – adjust up for your taste preference.

Classic German sauerkraut

1000 g shredded cabbage

11 g salt

¼ tsp of caraway seeds

½ an apple, diced (optional)

Pinch of yellow mustard seed (optional)

One thing I got used to in the time I spent in Germany was the taste of caraway seeds – I consider this the classic German spice, added as it is to all kinds of dishes from the very sweet, to the very sour. Caraway is a great spice for digestion, with a particular effect against flatulence. Caraway is also a stimulant, and a synergist par excellence – it enhances the efficacy of other food medicines when combined with them. As well as these benefits, caraway will work to prevent mould in the ferment, and proponents of love cooking will

be pleased to hear that one magical use of caraway is as an agent to promote love and to ensure fidelity in love. Caraway and apple are a traditional combination, even Shakespeare mentions the offer of “a pippin and a dish of caraways” in *Henry IV*. Too much apple may tend the ferment to mush, and be careful with the mustard seeds as well – mustard has a strong taste that only becomes stronger with fermentation.

Classic East European sauerkraut

1000 g shredded cabbage

11 g salt

7 juniper berries, crushed.

½ an apple, diced (optional)

Leaves of a small sprig of rosemary (optional)

Like caraway, juniper guards against mould, and is a synergistic herbal remedy with specific action as a diuretic, stomachic, and calmative. Like caraway as well, it is particularly effective against flatulence. We can see a common thread here of course – the two classic European spice additions both help digestion, ease flatulence, guard against mould, and have synergistic properties. We are safe to assume this is no accident. In fact, when we look into the common herbs and spices traditionally used to flavour our food, we find well documented medicinal benefits stemming from all of them. Magically, juniper can be used to focus intent or help achieve desired outcomes, and to remove barriers to higher consciousness.

Cortido, or Latin American sauerkraut

1000 g shredded cabbage

11 g salt

1 small onion, quartered lengthways and finely sliced

6 - 12 whole chillies, depending on size

2 tsp fresh oregano

Dash of Tabasco sauce, or chilli flakes

1 cup of pineapple vinegar

Cortido originates from the ex-patriot German community in El Salvador, and is a recent innovation. There are many variations on this theme, above are listed the defining ingredients. Chilli flakes may be substituted for whole chillies, in which case the Tabasco may be omitted; a lesser amount of pineapple juice may be substituted for the pineapple vinegar, perhaps with a tsp of apple cider vinegar; a lesser amount of dried oregano may be used; one or two shallots, sliced on the diagonal may be used instead of onion; and julienned carrot is sometimes added, very thin, about a quarter cup.

Russian sauerkraut (kisla kapoosta)

1000 g shredded cabbage

11 g salt

12 - 24)preferably dried) unsweetened cranberries (sub goji berries)

1 small sour green apple, diced

Some chopped dill leaf (optional)

Traditional recipes recommend low, bush-dried cranberries, but my thinking is that any unsweetened dried cranberry will do. The apple you use will depend on where you live – for example, I use Australia's Granny Smith variety. If unsweetened cranberry is not available, try dried goji berry instead.

I would suggest making at least one of most of these sauerkrauts before branching out to experiment with additional ingredients, and try a straight ferment using just cabbage and salt too. Once you have a few ferments under your belt, you will not only have the confidence to experiment, but the drive and passion as well. Remember fervour, from our introduction? You will come to know the taste of it well.

You might first wish to use red cabbage, either half/half or on its own for pink or red kraut. When using red cabbage, a little grated ginger does wonders bringing out the natural sweetness, which can be countered by the addition of a sliced spring onion or two, or by some chopped green seaweed such as kombu, or wakame. Don't forget the other herbs and spices of European tradition: dill, fennel, bay leaves, mustard seeds, and the like, and other vegetables like carrots, beets, or greens. Dark greens are strongly flavoured (e.g. kale), so use them sparingly at first. Learn about the medicinal benefits all these bring, and combine them to make your very own functional food ferment. A good starting point is as easy as entering a term like 'dill medicinal benefit', or 'beetroot nutritional value' into a search engine. Look for articles that include references to validate the claims being made, and bookmark sites you find useful. Libraries always contain an array of books on the healing properties of foods, allow yourself time to browse libraries and bookstores and make notes of anything of particular relevance to you and your family. There are no rules to sauerkraut fermentation, except as Sandor Katz notes, it basically just boils down to "chop, salt, pack, and wait". We can refine our technique certainly, and cleanliness is advisable, but as long as we follow the basic procedure as outlined in this and countless other books, we will be fine.

Sauerkraut includes whole or halved fermented cabbage heads as well, though of course a large crock will be needed for these, or a barrel!

Suan Cai

6 whole Chinese (napa) cabbages (sub sugarloaf cabbage)

6 L first rinse rice water

6 tbsp of rice wine or baijiu

6 tbsp Szechuan pepper corns, crushed

6 spring onions, sliced (optional)

6 garlic cloves, diced (optional)

Dried chillies, whole (optional)

Salt

Remove any damaged or yellowed outer leaves from the cabbages and discard. Wash the cabbages in clean water, cut the tough stalk base off neat with the curve of the lower outer leaves, and stand or lean the cabbages upright to dehydrate for several days. Halve the cabbages by making a small incision in the stalk base, and then gently pulling apart so as not to damage the inner leaves. Remove the outermost leaves and put aside (do not blanch these, as they will help to inoculate the ferment later). Bring a big pot of pure water to the boil. As it heats up, weigh the cabbages, and record (or memorise) the weight. When the water is boiling, hold each half cabbage under with tongs for 30 seconds, then remove and rinse in cold water immediately to stop the blanching.

Remembering the weight of our cabbage, measure out 11 g of salt per kg of cabbage, and place this in a bowl. Sprinkle a little of this salt into the bottom of your crock. First rinse rice water is the water drained off rice when it has had its first rinse. Hold each halved cabbage under the rice water, remove, and then rub a little of the salt into the cut surface. Place the halves cut side up in the crock until a layer is completed. Sprinkle a little of the pepper, rice wine and other ingredients (if using) on the surface, then lay some of the reserved outer leaves over the layer. Repeat this process until all the ingredients are used up.

Lay the last outer leaves over the top, then cover with a fine muslin cloth, tucking in the sides. Top up the crock with brined rice water. Measure 1 teaspoon of salt per cup of rice water, roughly 20 g per litre. Place your food

grade weight over the cloth; ideally your brine will cover the weight as well as the cloth. Ferment for 6 weeks minimum, the general consensus amongst Chinese people who ferment suan cai is that the longer it ferments, the better it gets. This recipe for suan cai is from Northeastern China, and for people in other parts of China (who have their own suan cai traditions), this is called dongbei suan cai. It goes well with pork in stews or dumplings, and versions of fermented cabbage and pork dishes can be found throughout East Asia.

Croatian sour cabbage (kiseli kupus)

12 whole cabbages

2 cups of salt

1 head of garlic, cloves peeled but whole

1 horseradish root, diced

2 fresh red capsicums, cut into thin strips

7 dried whole red capsicums

7 bay leaves

These are whole cabbage heads, fermented for six weeks in a large crock or barrel. The recipe is adapted from “The Best of Croatian Cooking”, by Liliana Pavicic and Gordana Pirker-Mosher.

Remove the outer cabbage leaves, reserving all that are undamaged and un-yellowed. Cut the core out of the cabbages, and fill each with salt. Lay 3 or 4 cabbages, cored side up, in the bottom of the crock, cover with a little of the spices, and add layers until all the ingredients are used. Cover with the reserved outer cabbage leaves, then a fine weave cloth (muslin or linen) and fill the crock or barrel with water. Cover the whole thing with a board or food

safe plate, and place sufficient weight on top of this to prevent the cabbages rising up during the fermentation process. Place a lid on the crock, a large, water moat crock would be the best choice of vessel. Let ferment for at least six weeks.

Hungarian sauerkraut

“For the worm that lives in a horseradish root, all the world is horseradish” – Hungarian Yiddish proverb

The origin and exact recipe of Europe’s first alcohol-based perfume are obscure, but the essence known as ‘Hungary Water’ most definitely featured rosemary. It seems likely that this 14th century concoction was devised as a

response to the Black Death that ravaged Europe from 1346 – 1350, as punters were advised to not only wear it as perfume, but also to bathe in it, and drink it. As well as it's well known anti-microbial properties, rosemary steeped water was used as a facial wash by the Queens of Hungary to reduce the ravages of age, and a rinse of rosemary tea will reduce and reverse that affliction known as greying of the hair in many instances. Regular culinary doses have a positive effect on memory and cognitive function, as Shakespeare's Ophelia confirms: "There's rosemary, that's for remembrance" (Hamlet, act 4, scene 5), and this quality is traditionally extended to include remembrance or fidelity in love.

On the other hand, we often have to travel a ways in the modern world before finding someone who loves the horseradish. This hot but humble root however is enjoying something of a renaissance of late, and there is good reason for that. The glucosinolates in cruciferous vegetables are known to increase human resistance to cancer formation and proliferation, and pound for pound the horseradish root is 10 times more potent than broccoli in this respect. On top of that, Russian researchers have discovered that horseradish extract has the ability to protect us from the mutagenic effects of environmental toxins. As a general antioxidant, horseradish is impressive too, strengthening the immune system, supercharging production and activity of white blood cells, and delivering a high dose of vitamin C to assist the body's action against free radicals. Antibiotic compounds in horseradish concentrate in the urine, making this root a useful aid in the treatment of urinary tract infections. It also contains enzymes that prevent toxins accumulating in the bladder, and its stimulating action on blood capillaries is a useful adjunct for resolving issues of water retention and erectile dysfunction. Horseradish is a good source of folate, B6, niacin, sodium, magnesium, potassium and zinc, and is used internally and as a poultice to treat respiratory tract infections and ailments. But whatever you do, don't feed it to your horse – it doesn't sit well with them.

1200 g shredded drumhead cabbage

300 g grated horseradish root

Leaves from a 7 inch sprig of rosemary

1 tsp smoked paprika (optional)

17 g salt

The usual sauerkraut making process follows – massage the salt into the ingredients well until a handful lifted triumphantly into the air and squeezed results in a good expression of brine. Pack into your jars, and leave in anaerobic conditions for 6 weeks minimum. The resulting kraut will have a good strong bite, will help clear congestion, will give you a greater protection against cancer than plain kraut, and will assist general bodily health through elevated antioxidant activity, potent natural antimicrobial action, and the natural synergy of rosemary and horseradish.

Before we put the lid on sauerkraut, following are two examples of krauts I have made recently.

Sauerkraut with red cabbage, spring onions, and kale

1 large green cabbage

1 small red cabbage

2 spring onions (shallots)

12 small curly kale leaves

3 cloves of garlic

6 sprigs of dill leaf

12 oregano leaves

Salt

Finely chop the cabbage. Cut the spring onions on the diagonal, including the greens. Tear the kale off the central stem, and into small pieces. Finally, finely dice the garlic, chop the dill weed, and leave the oregano leaves whole. Weigh the vegetable matter, and add salt at the ratio of 11 g/kg. Massage well until a goodly amount of brine is expressed when a handful is squeezed. Then pack into your fermenting vessel of choice, topping with either a rolled outer cabbage leaf, or layered outer leaves. Ensure all vegetable matter is submerged beneath the surface using a food safe weight, and then leave for six weeks. If you have no way to express CO_2 in your fermenting vessel (e.g. Mason jar), you will need to occasionally release the pressure. Do this by undoing the lid just enough to hear the hiss of pressure release, closing the lid tight immediately to reduce the amount of oxygen that gets in.

Aussie kraut - lemon myrtle, garlic and ginger

1 large green or red cabbage, shredded

7 lemon myrtle leaves, veins removed, finely chopped

2 thumbs of ginger, skin on, grated or finely chopped

6 cloves of Italian garlic, finely chopped (optional)

½ tsp caraway seed

Salt

This is my signature sauerkraut, and the one I make when I give sauerkraut making demonstrations at festivals, farmer's markets, workplaces and institutions. It also happens to be my wife's favourite, and since we used diet and fermented foods to halt and reverse her multiple sclerosis, I make sure the fridge is well-stocked with this beauty. We all know the drill by now – chop, salt, pack and wait.

A word on using natural antibacterial foods in fermentation

How is it that natural antibiotics appear to kill pathogenic bacteria while leaving probiotic bacteria intact? How is it that we can initiate and complete a successful ferment by including ingredients with known potent antimicrobial action? Garlic is the most widely studied of these, and what has been found is that garlic (and we may assume most natural antibiotics that appear to have a selective bias) does have some inhibitory action on lactic acid bacteria, but this is small compared to its action against pathogens. In a ferment, when we set the ideal environment for lactobacillic proliferation, this slight inhibitory action is eventually overcome by rapid growth of our target bacteria. Meanwhile, pathogens are outcompeted even more effectively. When we deliver natural antibiotics via our ferments, we enter the realm of true functional food – the sauerkraut above provides not only probiotics and natural antibiotics that affect pathogenic bacteria far more efficiently than they do probiotic bacteria, the fibre content of cabbage and the ginger skins are good prebiotics too. Lemon myrtle not only imparts a subtle lemon taste (due to the presence of the turpene limonene), but it is one of the few substances that can kill MRSA (golden staph). Most natural antibiotics also inhibit viral and fungal growth as well, and garlic in particular has been shown to be effective against *Candida* overgrowth. Garlic, ginger, caraway and lemon myrtle are all recognised immune system boosting and anti-inflammatory foods, which offers a natural support to the anti-pathogen actions they bring to our foods, particularly where there is a history of a compromised gut.

On top of all the internal benefits to be derived from eating this delicious, functional food ferment, the juice of this sauerkraut may be used topically to combat skin conditions such as school sores (MRSA infection) and ringworm. A reduced solution of boiled lemon myrtle leaves, or a 1% solution of the essential oil are also effective topically against school sores, ringworm, and the viral skin condition molluscum contagiosum.

Traditional Kimchi

Traditional Korean kimchi is technically a hybrid ferment – the cabbage is salted, then the brine is left in the bottom of the bowl as the cabbage is withdrawn to make the kimchi. Lactobacillic fermentation is initiated in the cabbage as it soaks in the salt, then the addition of a rice porridge adds a yeast component to give a combined bacteria/yeast ferment.

Tongbaechu-kimchi

There are many kinds of kimchi, but when Korean people say “kimchi”, this is the one they mean. The wombok (napa) cabbages are fermented in quarters, and a thick paste is made with sweet glutinous rice porridge, thinly cut vegetables, spices and Korean chilli flakes (gochugaru). The cabbage quarters

are salted and softened, rinsed, covered with the paste, and then wrapped around themselves. These little parcels are then layered and pressed into a crock with whatever remains of the paste being used to fill any gaps. The outside leaves of the cabbage are placed on top, and the kimchi is fermented for 5 days or so at before being transferred to cold storage. There is a lot of hands on work here, so making traditional Tongbaechu-kimchi presents the perfect opportunity to put the energy of love into our food. Korean people often eat this kimchi as is, without any fermentation, or after only 1 or 2 days have passed. Online resources for traditional kimchi are many and varied. This recipe draws mostly from the Maangchi website, I encourage you to visit this site to expand your kimchi repertoire.

Ingredients

3 large, or 4 meduim wombok cabbages

¾ to 1 cup Himalayan or other good salt

2 medium carrots

2 small daikon radishes

2 small turnip radishes

1 ½ cups garlic cloves

1 cup ginger root

½ cup Japanese parsley

4 large or 8 regular spring onions

1 large onion

1 cup fish sauce

2 cups of gochugaru (Korean chilli flakes)

4 cups water

4 tbsp raw sugar

4 tbsp glutinous rice flour

This will take some time, we will need some big bowls, and some way of draining a lot of cabbage. I used a colander and a wire rack over two different pots. First, we get the cabbage ready.

The cabbage

Remove the outer leaves of the cabbage, and put these aside. Examine the cabbage for any insect or grub holes, cut these out until any critter and damaged foliage are removed. Cut the stalk end neat with the rounded base of the cabbage, and place a 5 cm cut up the middle of the base of the cabbage. Possibly using the knife for initial leverage, we work our fingers into the cut and gently pull the cabbage into two halves. This prevents us shredding the

delicate inner leaves. Place a similar slit in the base of each half, but don't separate them into quarters just yet. Rinse the cabbage halves well in water, and place them all in one very big, or two big bowls.

Take a bit of salt and begin rubbing it all over the leaves while the cabbage is still wet. Lift each leaf and work a little salt into each one, using a little more toward the base where the leaves are thickest. Try not to break off any leaves. As they are done, they need to be laid or stood on end in a large tray(s) or bowl(s). If laying flat, they need turning, if stood on end they need upending, both regularly through the two hours the cabbage will sit with the salt on. Water will collect in the tray or bowl, this may be spooned over the cabbage halves, and they may be dunked in the brine occasionally. Whatever works best depending on the set up we have.

If using cut cabbage, rather than quartered womboks, cut the cabbage in squares about 1 or 2" x 2 or 3", and add 1 tbsp of salt per kg of cabbage. Soak for 4 – 8 hours.

After two hours, split the halves into quarters using the slit we put in earlier, rinse them well to remove the salt and any remaining dirt. Cut the bulk of the core away, leaving enough for the leaves to remain attached, then place them on a rack or in a colander to drain. Once mostly dry, our cabbages are ready to use.

The porridge

In a small pot, add the rice flour, then stir in the water to make a smooth liquid. Turn on the heat to medium, and cook for 10 minutes, until the liquid bubbles and thickens to a smooth porridge. Add the raw sugar, then stir and cook for another minute or so. Turn of the heat, and let this cool completely before adding to the paste. Do this as soon as the cabbages have begun the two hour soaking.

The vegetables

Cut the carrots and radishes into fine juliennes, or matchsticks. Cut the spring onion (whites and greens) thinly on the diagonal, then set aside. At all times during the handling of the ingredients, I like to maintain a focus of love and healing energy. In the photo below, as an extension of this, a balanced energy has been added to the mix during a meditative yin/yang arrangement of the carrot and radish juliennes.

The paste

Take the garlic, ginger and onion and either put in a food processor, or finely chop by hand. In a large bowl, add the fish sauce, the finely chopped spice mix, and the chilli flakes, then stir. Stir in the cooled porridge. Stir in the vegetables until a thick and lumpy paste is formed. We are now ready to lay each wombok quarter into the paste bowl one by one, and to work in the paste.

Make sure the spaces between the leaves are well covered. Work the paste in there, and massage it into the outsides, especially the lower part where the leaves are thickest. This is a great time to put love energy into the food. We are lovingly opening the leaves and pasting them with goodness and taste, good energy is easily transferred in operations like this. Love your kimchi!

Once well coated, fold the quarter in on itself to make a little parcel. They are very soft now, this will be easy to do.

Pack each quarter into a large ceramic crock, trying not to leave any airspace. Pack bits of paste or shed leaves into any gaps, and continue until the crock is packed. Spoon any remaining paste over the top. Take the outside leaves we reserved at the start, wash them very well, and trim any dead or dry matter. Layer these on top of the kimchi, pushing down as you go to express any air that may be trapped. Once you have layered all the leaves, put the lid on the crock and let ferment for 3 – 7 days. After 5 days, eat some to test, and place the rest in glass jars for cold storage when to your taste. In Korea, they call this ready any time from 3 to 21 days, depending on personal taste.

This is food that should be eaten fresh, though it will store well in the fridge. Refrigeration slows down fermentation, but it does not stop it. The longer the kimchi is in the fridge, the sourer the taste will become.

Hobak kimchi

The Korean word hobak (호박) is a little confusing because you may hear it applied to either a pumpkin or a zucchini. Actually, it's a kind of generic term for 'squash', and to distinguish zucchini from pumpkins and squashes, some Korean people will call the zucchini ae-hobak. Because we are fermenting here, the firmer, pumpkin-like hobak are used. If you can find a yellow Asian squash, great! If not, anything similar to a butternut squash, or indeed any pumpkin or firm orange or yellow squash may be used for this recipe.

If you don't think this ferment is a bit special, try entering the term 'hobak kimchi' into a search engine and see how many hits you get. Not many, and when you offer this to friends, it's fairly likely they will never have tasted it before.

Ingredients

1.5 kg squash, cut into ‘cubes’ 2.5 – 5 cm x 2.5 – 5 cm x 2.5 cm (approx 3 lb at 1 – 2 x 1 – 2 x 1 inches). After an initial period sitting in some salt, the 2.5 cm (1 inch) thickness will be cut again in half so the thickness is about 12 – 13 mm, or ½ an inch.

9 – 11 outer leaves of wombok (Napa, or Chinese) cabbage

2 large spring onions (shallots) cut on the diagonal, white and green parts

1 palm-sized piece of ginger

Garlic cloves, enough to fit in a closed hand

1 ½ tbsp gochugaru (or any chilli flakes)

1 ½ tbsp gochujang

4 tbsp salt (most will be drained off)

1 tbsp coconut or palm sugar

1 ½ tbsp glutinous rice flour

1 cup water

¼ - ½ cup fish sauce (preservative free)

Step 1 – salt the squash

Peel the squash, and cut it to the sizes listed in the ingredient section. Take the squash (we will cut them in half later), place in a large bowl, and add 3 tbsp of salt. I used Himalayan salt, but good quality sea or rock salt is good. No table or pickling salt please. Place the whole wombok leaves over the squash, then cover with muslin or some other fine-woven cloth. Every hour if possible give the squash a bit of a mix up to spread the salt (and the brine that will have formed in the bottom). 8 – 10 hours is an absolute minimum, I did mine for about 20 hours.

Step 2 – make some porridge

Glutinous rice flour is the base of this porridge, a standard addition to many kimchi. In 1 cup of cold water, stir in 1 ½ tbsp glutinous (sticky) rice porridge. Turn the heat to low and cook slowly, stirring regularly to ensure the porridge is smooth. When it has thickened in 10 – 20 minutes, depending on the temperature you use, turn off the heat and stir in 1 ½ tbsp of coconut or palm sugar. Set this aside to cool, you will want to make this about an hour before you are ready to put together your hobak kimchi.

Step 3 – prepare your spice paste

Finely grate, food process, or bullet blend the ginger and garlic. Add to this the gochugaru (Korean chilli flakes, but any chilli flakes will do for a sub), the gochujang (fermented soy-based Korean chilli paste), the fish sauce, and 1 tbsp salt. If you can't get gochujang, just use double the amount of chilli flakes. Please note the gochujang fermentation is partially activated by a wheat

enzyme, and though I would consider this food 'gluten free', those with a serious gluten reaction (e.g. anaphylactic shock) should avoid this product. Once the rice porridge has cooled, add it to the spice paste and mix well.

Step 4 – prepare the green stuff

I call them spring onions, others call them shallots, and there are no doubt other names floating around out there, but since they are pictured above, we are all on the same page. Trim sub-standard growth, usually the outermost leaf sheath and the very tips, trim the roots, then slice these on the diagonal. A diagonal slice across the fibres, in my opinion, opens up subtle nuances of taste that the straight cut doesn't. Cut them straight if you like, but I think they are also more aesthetically pleasing when cut diagonally. Take the cabbage leaves off the squash, and shred thinly. Cut the thickened midvein (the white basal material) more finely. When done, add the green stuff to the spice paste and stir well.

Step 5 – drain the squash

Pour out all the brine, then give the squash several rinses in clean water. Either allow them to drain for at least an hour in a sieve or colander, or pat dry with a clean cloth or kitchen paper. Take each piece of squash and cut in half at the thinnest edge, roughly giving you pieces 12 – 13 mm (1/2 inch) thick. Once rinsed, dry, and cut, we are ready to put it all together.

Step 6 – put it all together

Place the squash in a big bowl, and rub the spice paste with the veg well into the pieces. Every surface wants to be thinly coated with the paste, this won't be immediately apparent to the eye, but a through mixing will indeed make this so. This is the perfect time to put the energy of love into your food. As you

mix with your hands, take your energy into your heart, think of all those you love who will be enjoying this delicious ferment, and send that love out of your hands, and into the food. All the universe is energy, so putting good energy into our food increases its ability to nourish and heal. Even if you don't believe this, the benefits of entering a meditative state are well documented, so why not? Having said that, most cultures on earth (other than the Anglo-European ones) recognise and promote the benefits of 'love cooking'. Think back to the meals you have had – which where the tastiest and most pleasing to mind/body/spirit? Those cooked with resentment, or those cooked with love?

Step 7 – jar it up

This is a short ferment, so an airlock is not necessary. Place the mixture evenly into whichever glass or ceramic vessels you are using, and share the remaining liquid evenly between them, and then close the lid tight. Let these sit on the bench at room temperature for 3 – 5 days, depending on ambient temperatures (3 days if it's hot, 5 days if it's cool).

Yellow kimchi

1 wombok (napa) cabbage

3 medium carrots

3 small white radishes

Big handful of garlic cloves

Palm sized piece of ginger root

Thumb sized piece of turmeric root

Handful of chopped wakame

1 apple

1 onion

3 cups of water

3 tbsp glutinous rice flour

3 tbsp raw sugar or coconut sugar

9 lemon myrtle leaves

8 tsp salt

Remove the outer leaves of the cabbage, rinse it, and cut into big squares, about 5 x 5 cm. Julienne the carrots and radishes. Place the cabbage, carrot, radish and wakame in a bowl and add 5 tsp of salt. Mix well and allow to sit for 2 or 3 hours, turning occasionally.

Place the water and rice in a small saucepan, and cook on a medium heat for 10 minutes, stirring often, until the mixture thickens and bubbles. Add the sugar, stir and cook for a minute or so more, and then allow to cool.

Cut the veins out of the lemon myrtle leaves and chop. Roughly chop the garlic, ginger, turmeric, apple and onion, and place in a food processor with the myrtle leaves. Process to a rough but fairly fine paste. Or do all that by hand.

Drain the brine from the vegetables. Mix the cooled rice porridge into the spice paste, then add the whole to the vegetables. Sprinkle 2 or 3 tsp of salt over the lot, and mix well. Place the yellow kimchi in a crock or individual jars and ferment for at least 5 days. When the taste is to your satisfaction, transfer to cold storage and eat within a month.

White Kimchi, Thai style

The magic of Thai food is founded on the balance of the five flavours: sour, sweet, salty, bitter, and spicy. What then differentiates Thai food from other cuisines that employ taste balancing are the ingredients that are used to bring each flavour to the mix. Vegetables, fruit, herbs, spices, and condiments are all

used to contribute to the final dish, and for this white kimchi in Thai style, I utilise many ingredients that will be familiar to those who love Thai food.

These are the steps you need to take to make your very own Thai-chi.

Ingredients

2 wombok (Napa) cabbages

4 bok choy

1 large daikon or several smaller radishes of any variety

2 carrots

Palm sized piece of ginger

2 heads (not cloves) of Italian, or one head Russian garlic

2 spring onions (sometimes called shallots in other parts of the world – this is the small, white, leek-like onion with a white head and green tops), cut on the diagonal.

1 brown onion

1 Asian (nashi) pear or apple of any kind

4 cups water

4 tbsp sticky (glutinous) rice flour

4 tbsp coconut or palm sugar

Thai master stock (see below, extra ingredients required)

1 tbsp of salt per kg (near enough 2 lb) of cabbage and bok choy)

6 or more kaffir lime leaves, whole.

1 stem of lemon grass, finely chopped

Generous dash of preservative free fish sauce

Some chopped water dropwort or Thai morning glory (optional, these are hard to get)

Fish sauce, a good dash, about a couple of tbsp minimum, but add to taste.

The Cabbage and Bok Choy

Take two good sized, organic or chemical free wombok (Napa) cabbages, and three or four similarly clean bok choy. Remove the scrappy outermost leaves (if any), then take the first good outer leaves of the cabbage, and put these aside. Examine the cabbage for any insect or grub holes, cut these out until any critter and damaged foliage are removed. Chewed leaves are OK if they are healthy and relatively intact – the action of invertebrate chewing activates the potently anti-cancer glucosinolates in all cruciferous vegetables. Bok choy needs less cleaning up, use the maxim 'if you wouldn't eat it, don't ferment it'. Cut all cabbages (bok choy is technically a kind of cabbage, and higher in vitamin A potential than any other cabbage). Chop these into rough 2 x 3 inch squares, it doesn't really matter what size they are, just as long as they are not shredded. Weigh the chopped veg, then add 3 tbsp of salt for every approximate kg of veg. Place the veg into some large bowls, add the salt, and rub it into all the surfaces. Give a quick but gentle massage, cover the bowls with a tea towel or cloth, then leave for round about 4 hours. Now make the Thai master stock.

Thai Master Stock

You should always make this if you want to make Thai food. Add a little to each dish and it will add coherence to even the most diverse flavours offered. The exact amounts will depend on the freshness of your ingredients, and the

intensity of their taste. Use the recipe below as a rough guide, and adjust the fish sauce, soy sauce, salt, lime juice and sugar toward the end of cooking to achieve the required balance.

1 litre of water

1 small onion, sliced

1 inch of galangal root, chopped in rounds

2 thumb-sized pieces of lemon grass

3 or 4 kaffir lime leaves

A dash of fish sauce

A dash of thin soy sauce

The juice from 1 or 2 lime cheeks

1 – 3 tsp coconut sugar, or dark palm sugar

Salt to taste (you won't need too much, the soy and fish sauces are already salty)

Simmer the onion in the water on a low heat for 5 minutes or so, then add the galangal, lemon grass and lime leaves. Low simmer for 10 minutes, then add about half of the other ingredients. Simmer for 10 minutes more, then taste. Add the remainder of the other ingredients to achieve your own personal balance of the flavours. Put the master stock aside so it is well cooled before using, and make a standard sticky rice porridge as you would for any kimchi. For those who have never done this, I will explain that now.

Sticky rice porridge

4 cups water

4 tbsp coconut or palm sugar

4 tbsp sticky (glutinous) rice flour

In a small pot, add the rice flour, then stir in the water to make a smooth liquid. Turn the heat to low medium and cook for 10 minutes, stirring often, until the liquid bubbles and thickens to a smooth porridge. Add the raw sugar, then stir and cook for another minute. Turn of the heat, and let this cool completely before using.

The vegetable paste

Julienne the carrot and radish, chop the spring onion, and put in a big bowl. Add a good dash of fish sauce and stir well. Take the onion, garlic, pear (or apple), and ginger and cut finely, in a food processor if you have one. Add this to the bowl. Combine the porridge and Thai master stock with the vegetables, add finely chopped lemon grass and whole kaffir lime leaves, then stir well.

Putting it all together

Drain any liquid (brine) from the cabbage and bok choy, and reserve the brine. We might use this later. Divide the vegetable paste evenly between your bowls, and coat the cabbage and bok choy well with it. Lick your fingers. How salty does it taste? If it doesn't taste noticeably salty, add brine until there is a good salt tang. Mix again for luck, and then transfer to your fermenting vessel(s). This is a light kimchi with a high salt percentage that favours secondary and tertiary fermentation species, so a week is all that is needed. Because we only ferment this for a week, precautions to guard against mould are not absolutely necessary. That means you can get away with fermenting in

a crock without a moat, or in jars without an airlock (but remember to monitor pressure and release as necessary). Once fermented, decant to sterilised jars, let sit on the bench or in the cupboard for a few days to build up a headspace of CO2, then store in the fridge.

Carrot, green mango and ginger

This is a simple and quick recipe that uses sauerkraut brine and a cabbage leaf to inoculate the ferment (bring desired bacteria). We inoculate this ferment because carrots go slimy very quickly under fermentation, so we want to speed things along. Don't use whey (which has dairy-based bacteria) to inoculate a vegetable ferment.

Ingredients

2 – 3 carrots

1 small green mango, or green papaya/paw paw

Thumb-sized piece of ginger

2 tbsp sauerkraut brine

1 ½ tsp salt

1 cabbage leaf

Grate the veg and place in a bowl. Add the brine and the salt, give a quick massage, then pack into a jar. Place the cabbage leaf on top, then weigh it down and seal the jar. This will be ready from 3 – 7 days depending on ambient temperature.

Onion with turmeric and yellow mustard seed

Ingredients

2 large onions

Finger sized piece of turmeric root

½ tsp yellow mustard seed

2 tbsp sauerkraut brine

1 cup of water

1 – 1 ½ tsp salt

1 cabbage leaf

3 bay laves (optional)

Peel the onions, then cut them in half. Slice each half into half rounds, not too thin. Grate the turmeric, and combine the water, salt and sauerkraut brine in a cup. Layer the onions in a jar, adding a bit of turmeric, mustard seed and bay leaves as you go. When full, pour in the brine mix. If it doesn't quite cover the veg, mix another half cup of water with ½ tsp salt and add until covering. Place the cabbage leaf on top, then weigh the veg down, and seal the jar. This will be ready between 1 – 3 weeks, depending on how you like it.

Kabu no sokuseki-zuke

Or more simply, Japanese salted turnips!

Ingredients

2 – 3 turnips, cut into very thin strips, or grated

2 tsp salt

1 tsp grated lemon rind

Sesame seeds

Rub the salt into the turnip strips, then add the lemon rind. Place in bowl covered with a cloth for a few hours and eat straight away, or transfer to a jar to ferment for a few days. Sprinkle with sesame seeds when serving if wished.

Did someone say turnips? Let's look at what Europeans do with the turnip next!

Sauerruben

We all know the sauer in sauerkraut means sour, and kraut means cabbage, so what is a ruben? Ruben, again from the German, is turnip, and sour turnip is a popular ferment in the countries that have a strong sauerkraut tradition. The humble and much maligned turnip is an excellent food, and both the root and the greens can be eaten (the greens in fact are a wonderfully nutrient dense food). As a society though, we perhaps don't give the turnip the respect it

deserves. A ‘rube’ is a coarse, simple, unsophisticated or gullible person, and more than one commentator has made much of the fact that the farmer whose truck ended James Dean’s life was one Mr Turnipseed, the name itself apparently implying a certain lack of sophistication and intellect to city-dwelling chroniclers of society and fashion. In England, the turnip (sometimes called the mangelwurzel) is often seen as emblematic of stupidity, to the extent that when a newspaper there mounted a campaign to replace the manager of the English football team, the deciding factor leading to his eventual demise appeared to have been a front page photograph of the man’s face superimposed over a turnip. Rarely has a vegetable been so universally despised (except perhaps for Brussels sprouts), but sauerruben provides the turnip with its chance to shine, to claw its way back to respectability, and back onto the plate.

Turnips hold a lot of water, so this is an easy self-brining ferment if the root is finely julienned or grated. Thicker pieces of turnip can also be fermented, and to speed up the preparation, a brine can be used. At its simplest, making sour turnips is just like making sour cabbage, except it’s easier. Like sauerkraut, sauerruben adjusts to changing tastes as we head east from Germany. We will look at these regional variations later, but for now, I would like to introduce you all to classic German sauerruben.

Classic Sauerruben

There is no denying the fact that turnip has a strong taste. Classic sauerruben has but two ingredients: turnip and salt. There is no hiding from the turnip taste here; rather we embrace it in the form of the souring action of wild lactobacillic fermentation. As an appetite stimulant, digestive aid, palate cleanser, and breath freshener, this ferment is hard to beat. For best results in all root-based ferments, use small young roots to avoid fibrous or floury flesh, to avoid harsh tastes, and to have more concentrated nutrient density. I use

the same ratio of salt as I do for my sauerkraut in this ferment, but feel free to use a little more if that is to your taste.

1 kg turnip, finely julienned or grated

11 g of salt

Place the turnip in a bowl, and then add the salt. Massage the turnip gently – because of the high water content and relative softness of the cut ruben this will require both less effort, and less time than a kraut massage. Push the massaged turnip down firmly into your fermenting vessel, ensuring all air is expelled as you build up the layers. Leave room for expansion at the top, cover with a food safe weight to keep the turnip below the brine, and then seal your vessel. You will have to allow some way for the CO_2 to be expelled, there will be a lot of it; please consult the equipment chapter for strategies. You may start eating this any time after a week has passed. It is better after three weeks and, for my taste, even better when left for longer.

Classic Thick Sauerruben

Thickly cut slices of turnip utilising a brine mixture, with a little dill leaf for good measure.

1 kg turnip, thickly julienned

2 – 3 cups of water

2 – 3 tsp of salt

2 tbsp of dill leaf.

Pack the turnips and dill leaf into your fermenting vessel, then top with a brine to the ratio of one teaspoon of salt to one cup of water. You will most likely use two or three cups. Cover the turnips with a food safe weight, and seal your vessel. The fermentation time and requirements are the same as for classic sauerruben.

Kisla repa – Slovenian sour turnip.

Eastern Europe is a fascinating place from a food perspective, and this isn't just because of the Bulgarian blood that contributes to my heritage. Or maybe it is. Nevertheless, it has been said that there are 70 distinct cuisines or culinary traditions in Slovenia alone, so the inspiration for cooks and fermenters interested in Eastern Europe is rich indeed.

This Slovenian inspired ferment – kisla repa – is the eastern version of sauerruben. Two medium turnips are cut into fine julienne strips, to which is been added one fennel bulb with stalk and some leaf, cut finely. To spice it up, we add some grated turmeric, some cumin and coriander seed, some chilli flakes, black pepper corns, and some sweet paprika.

800 g turnip, finely julienned or coarsely grated

200 g fennel bulb and stalk plus a little leaf, cut finely

1 tsp grated turmeric

1 tsp of equal parts cumin and coriander seed

1 tsp chilli flakes

½ tsp sweet paprika powder

11 g salt

3 black pepper corns

This is a self brining ferment, pack tightly and set as for classic sauerruben. As with all ferments, experiment and get to know how the different additions affect the taste. Looking at the regional variations for sauerkraut will also give you ideas for your sauerruben. Here are some suggestions for additional ingredients to add to a turnip ferment. Grated or julienned turnip plus: cumin seed; caraway seed; bay leaf, paprika, and horseradish; chilli peppers and horseradish; bay leaf, fennel, turmeric, and pepper corns, and; sour green apple and unsweetened dried cranberry (or goji berry). Also try swapping some portion of the turnip for carrot, which will make for a sweeter and milder sauerruben. And lastly? Cabbage goes pretty well with sauerruben too.

Fermented cauliflower

Cauliflower is the easiest thing in the world to ferment, in fact, a recipe format is not needed. All we need to know is that at a bare minimum, the cut cauliflower florets are placed in a 2% brine, weighted down (a cabbage leaf on top will help kickstart the ferment), and then sealed. Cauliflowers remain firm, but soft enough to bite - al dente would be the correct term. Ferment these for 2 – 6 weeks, depending on preference, add a little more salt if you wish, and experiment with flavours. Carrot, garlic, chilli, turmeric, ginger, fennel, dill, bay leaf, Indian spices – all will go well the cauliflower ferment. The only caution is the rule that strong spices can overtake the taste of a ferment so … less is more!

The trouble with mould

Moulds are single-celled fungi that appear multi-cellular because they grow in filament-like segments called hyphae. They are a taxonomically diverse group, thousands of species are known, but many more remain unknown. Within the fungal group, it is estimated that only about 7-8% of all species have been taxonomically described. Moulds are fairly benign, some are beneficial and are used in fermentation and other applications, while others still are mildly to extremely pathogenic. Pathogenic effect may be as simple as a mild to serious allergic type reaction to spores or fungal growth inside or outside the body, or as extreme as muscle wasting, neurological damage, or even death from the effects of mycotoxins. There is no 100% reliable way of telling which mould is which is which with the naked eye.

Mycotoxins vary, but some of them are amongst the most toxic substances on earth, widely considered to be more detrimental to health than heavy metals or pesticides. They should be considered as a defence mechanism, by which the mould protects itself from bacteria, viruses, and higher life forms. Attacking a mould ineffectually increases the output of mycotoxins, and we will get back to that very important point later. Another point we will get back to then is the fact that yeasts are also single-celled fungi that may exhibit the form of pseudo-hyphae (mimicking the habit of moulds) by conjoining, and like moulds, many can and do produce mycotoxins when threatened. Many of the symptoms of a Candida albicans overgrowth, for example, may be attributed to the production of mycotoxins.

So given that many moulds are toxic, even potentially deadly, and that there is no way of telling one mould from another with the human eye, and then considering that moulds mutate with such ease and rapidity, so that even lay-person identification with a microscope is no guarantee of safety, we might like to know under what circumstances is mould safe in a food context. It stands to reason that mycotoxins will not harm us until we ingest or inhale them, so we want to avoid doing that as far as possible. Which brings us to the question of mould and fermented foods. At what level, or in what state, is

mould safe to remove? Is the advice we receive about mould correct, or should we exercise more caution?

This is standard advice about mould, as can be found in books and forums devoted to fermentation:

- Just scrape it off, what's underneath is fine
- It's only toxic if it's coloured brightly
- A little bit won't kill you
- Our grandparents didn't worry about it
- If you get it quick enough, there will be no mycotoxins

Now, this isn't to say the people who give this advice are callous or ignorant or cavalier – they are intelligent, well-meaning people, repeating what they have heard or read or assumed based on received wisdom. As we shall see later, the danger with received wisdom is that is often formulated under conditions very different to those we know now. So, we may well ask has mould in foods and mycotoxin distribution been investigated scientifically. The answer to that is: yes it has.

Both the CSIRO in Australia, and the USDA in the United States have determined through analysis that once mould is visible to the naked eye, the hyphae have already penetrated well below the surface. Mycotoxins are predominately produced by the spreading tip of the hyphae to negate competition from other organisms. This means that in a soft or liquid medium, the hyphae, spores and mycotoxins are fairly well distributed. In a brine based ferment (including self-brining ferments like sauerkraut), this means that mycotoxins will be present throughout the entire fermenting vessel. There are no exceptions to this fact. If there is mould on the surface of your ferment, it is all the way through it. The choice is then yours – keep it, it chuck it. You may decide that the chances of one of the highly toxic moulds having colonised your ferment are fairly slim, and this may in fact be the case, but even the

moulds which produce relatively mild mycotoxins can become a real hazard to health under certain conditions. One of those conditions is EM pollution.

Electro-magnetic pollution is a fact of modern life, and there is hardly anywhere free from its effects. Let's have a look at what some recent studies have shown:

- EM exposure found to encourage mould growth
- Ionising radiation (from EM exposure) encourages mould growth
- Candida overgrowth triggered by EM exposure
- EM exposure increase potency of mycotoxins released
- EM exposure increases level of mycotoxin release by up to 600%

So, unless you live somewhere remote, where you have no power, and are outside of mobile phone range, then you might like to think twice before giving that ferment to yourself or your children because it was just a little bit of mould, and you got it very quickly.

Goitrogens

There has been a huge rise in hypothyroidism in recent times, particularly in women, and much attention has been directed by scientists and physicians to the so called goitrogenic foods – cruciferous vegetables. Goitrogens are foods that inhibit bodily uptake of iodine, or that inhibit the utilisation of iodine by the thyroid gland, and so are implicated in hypothyroidism, related goitre formation, and thyroid cancer. Goitrogens also inhibit the transfer of iodine to breast milk. At the same time, these foods are widely touted by scientists and physicians to have anti-cancer and detoxifying properties, and strangely enough, both the pro and con arguments for cruciferous vegetables revolve around the same group of compounds – the glucosinolates.

The different forms of glucosinolates in crucifers are broken down in the body to three groups of compounds: isothiocyanates, indoles, and nitriles. All three groups have been studied for either potent anti-carcinogenic, detoxification, anti-viral, or anti-bacterial properties. All three groups have also been identified as potentially harmful, with effects such as inhibition of thyroid hormone production, and tissue-based cyanide toxicity having been experimentally demonstrated. A word of caution here: many experiments are conducted at higher doses than would be found in food, on isolated compounds only (so not as found in nature), and obviously, rarely on humans. Regardless of this caveat, we tend to base our choices on what these kinds of experiments show us, and when there is conflicting advice, we can be understandably confused.

First, we should understand that glucosinolates are a part of the crucifer defence mechanism against herbivory. They are inert substances until activated by the accompanying enzyme myrosinase. In the plant tissue, glucosinolates and myrosinase are segregated, but the action of chewing breaks down the compartment walls, and the formation of what is fundamentally a range of irritant and toxic chemicals is initiated. In humans, high doses of these toxins are required to initiate substantial effects. For example, isothiocyanates are metabolised in the body into two functional groups: thiocyanate ions and thioureas, with the former being produced in much larger numbers. Thiocyanate ions inhibit uptake of iodine by the thyroid gland, but this can be ameliorated by a sufficiency of iodine in the diet. Thioureas, however, shut down the enzyme that allows iodine to be used in the manufacture of thyroid hormones. In a nut shell, dietary iodine can allow the body to cope with low levels of isothiocyantes, but not high levels. The effects of iodine deficiency are exacerbated by a bodily lack of vitamins A and E, selenium, zinc and iron. This indicates that while crucifers confer health benefits, we should eat them sparingly, and ensure we have adequate dietary iodine, selenium, zinc, iron, and vitamins A and E. In other words, we could say treat crucifers as a medicine food that fits into a well balanced diet, one in which they are not eaten in great quantity.

Reduction in thyroid function may result from many factors, and these often occur in concert, and on a regular basis. A few quick examples of this are: habitual use of refined sugars and starches, particular without fats or protein as balance, depletes the thyroid of hormones as these are part of the emergency blood sugar balancing response of the body; repeated exposure to endocrine disrupters that inhibit thyroid activity such as fluoride (in drinking water), and phytoestrogens, (for example from soy products); exposure to dioxins, PCBs, EBDCs and perchlorate; and exposure to high levels of ionising radiation (including X-rays). Even though endocrine disrupters work in concert, they are studied in isolation, so the combined effects of disrupters on thyroid function are most likely greatly in excess of any single effect reported in scientific literature. Disruption of thyroid function may be tied to overall hormonal imbalance, and it is worth noting that women are more likely to become hypothyroid immediately after childbirth, and after menopause. Avoidance of known external endocrine disrupters is therefore of particular importance to women, and hormonal means of birth control must be included in this consideration.

The fermentation of food does not destroy goitrogens, cruciferous vegetables need to be well boiled for an extended period to reduce the goitrogen content by 90%. But then, fermented foods are only ever intended to be a condiment, and one addition to a well balanced diet. The inclusion of cruciferous vegetables to ferments conveys many health benefits, and there is no reason not to ferment them as long as we maintain adequate dietary inputs of iodine, selenium, zinc, iron, and vitamins A and E. Here is a list of good thyroid foods, but remember, they must be organic to be most beneficial: most seafoods (though amounts vary depending on iodine in home waters), kelp and other seaweeds (reliable high levels, the best source), unrefined sea salt, Himalayan salt, fish and bone broths, dark green vegetables (though some report that spinach blocks iodine absorption), butter and other dairy (preferably raw, and from grass-fed animals), eggs, kefir and yogurt, oregano, strawberries, cranberries, artichokes, asparagus, and navy beans.

Histamine

Histamine is a nitrogen based compound involved in immune response and regulation of the gut that also function as neurotransmitters, with effects on sleep-wake cycles and the uptake of testosterone, to name but two. There will be many functions for histamines in the body that are as of yet unknown, to date we know of 23 of them. Histamines are released by the body in times of stress and allergy or foreign protein attack, their release in an immunological sense is triggered by contact of an allergen with an antibody bound cell. These cells are most common at the sites of greatest potential injury, for example: lungs, mouth, nose, sinuses, surface of the intestinal lumen (basically, gut-tube), and the blood vessels. Most people know about histamines from symptoms related to these sites. Histamines occur naturally in the body and in some foods, and a few foods promote histamine production. Fermented foods are known to increase histamine levels, so when we ferment foods that are naturally high in histamines, or actively promote histamine production, we are increasing their already high levels of histamines. The most relevant foods for basic fermentation practices are cabbage (high histamine level), and milk (promotes histamine production).

It is common for us, with the cultural influences we have, to believe that more of a good thing can only be better. This is part of a fundamental predisposition to addiction that exists within most cultures of the earth, and in the case of fermented foods, less is definitely more. This is most important when first trying fermented foods, and because many people who develop an interest in fermented foods are interested in addressing some specific (or even general) health concern, quite often the immune response/inflammation cycle is already in place, and dumping high levels of histamines into such a system is a recipe for disaster.

There is a legitimate cause of symptoms that mirror the symptoms of histamine overload or intolerance in the realm of fermented foods, and this is

the phenomenon called ‘die back’. Basically, as good bacteria replace bad bacteria within the different niches of the gut, the bad guys die, and if they die in number, quite a toxic load is placed on the body, and until the body can deal with this, there can symptoms of nausea, irritation of the mind of the mucosal membranes, headache, itching, intolerance to stimuli, etc. This is akin to the ‘healing crisis’ in many bodily therapies where toxins are released for elimination, but as a reflexologist, my goal was always to work to the point just below where these effects would become apparent. A high toxic load never does anyone any good.

So, the advice of well meaning people when told about these symptoms can run like this – “it’s die off, it’s a good thing. It means you’re getting better. Take more fermented food. You’ll see, you’ll be fine”. Most often though, this is not die off, but a histamine reaction, and pumping more histamines into an inflamed system can do no good. Many people go through this, follow the wrong advice, and eventually give up fermented foods for good, thinking “they are just not for me”. This is a shame.

Even the most robustly healthy individual shouldn’t eat vast amounts of fermented food on a regular basis. There is just no need, and as discussed in the previous sections, there may be pitfalls. With fermented food, less is more; we can’t repeat that to ourselves enough. We want a variety of different ferments, just a little of each, but regularly. When first starting out, take it easy, and begin with near homeopathic doses, especially if you know you have a sensitive gut. Milk kefir, which is an amazing health tonic on so many levels, can cause severe histamine reactions if too much is consumed too soon. Start with a teaspoon a day for a few days and listen to your body. If all is well, take a bit more for a few days, and so on. Having a cup out of the blue won’t do you much harm, but starting on a cup or more, and having that every day may cause problems. Or it may not. The best skill we can cultivate is the ability to listen to our bodies.

Glutamate

Cabbage is a high glutamine food, and since glutamine is easily converted to glutamate in the body, many people with neurological disorders are advised against eating cabbage, especially fermented cabbage. I myself have had much correspondence from people with children on the autistic spectrum who confirm that fermented foods can be a problem in this context. Whether glutamate, histamine, or some other agency is the root cause of this reaction is hard to determine, and most likely a number of factors are at play, and these will differ from individual to individual, and even from time to time. While serious reactions to fermented foods by anyone with a pre-existing condition are best addressed by a medical or nutritional professional via face to face consultation, I can share what I have learned about these issues, starting here with glutamate. As always, this does not constitute medical advice in any way, but offers avenues of research for each individual and their consulting professionals.

People hear the word glutamate and tend to shudder. We associate it with mono-sodium glutamate (MSG), and we have all heard how bad this is for our nerves, so the assumption is that all glutamate is bad, and we should seek to reduce it. In fact, glutamate not only plays a key role in cellular metabolism, it is also the most abundant excitatory neurotransmitter in the body. Without it, we simply could not function. We will focus on the nerve exciting qualities, because this is where the problems with glutamate can lie within us. We won't be thinking about how to avoid it, but how to allow it to return to a natural state of balance in the body via assisting with that complex set of reactions that is the glutamine/glutamate/GABA conversion cycle. We won't even attempt to navigate that complexity, we only need to know that: glutamine is derived from our food, but can be manufactured by the healthy body if necessary; glutamine is converted to glutamate; glutamate is converted to GABA (pyridoxal phosphate, the active form of vitamin B6 is an essential co-factor for the transformation); GABA is converted glutamate; glutamate is converted to glutamine; all the action usually takes place in the nerve synapse,

though external factors such as the action of some species of lactic acid bacteria can form both glutamte and GABA outside the body, and; other co-factors will influence the cycle, for example L-theanine facilitates GABA conversion. Before we move on, best mention that *gamma*-Aminobutyric acid (GABA), as well as influencing muscle tone, is the most abundant relaxant neurotransmitter in the body. Simplified, glutamate fires up the nerves and GABA calms them down, and in an ideal world, this all works out smoothly. Consider conditions where the nerves are attacked or impaired – this generally co-occurs with a reduction in muscle tone, perhaps an indication for us that GABA conversion is sub-optimal.

In neural disturbance or damage related to excess glutamates, the action appears to be that excess glutamate outside the nerve draws free systemic calcium into contact with the nerves, initiating a chemical reaction that strips or damages the myelin sheath that insulates the nerves (in much the same way that the plastic coating on electrical cables insulates the live wires). One researcher (Dr Nancy Mullen) puts it this way: if glutamate is the gun of nerve damage, then calcium is the bullet. There are two factors that must play out before this can happen though. The glutamate in the nerve synapse is not being converted to GABA, and some agency, most likely an influx of leukocytes or activation of microglia, is displacing the glutamate from the synapse, and allowing it to pool around the outside of the nerve. Microglia are the central nervous system's immune cells, and activated microglia are to be found excessively in most cases of neural damage or dysfunction, including autism. There is a growing body of evidence that continual exposure to neurotoxins like mercury, formaldehyde and fluoride, and to other adjuvants commonly used in medical and agricultural applications is to blame for the continuous increase in nervous system dysfunction and disease right across the board. Overstimulation of the immune system, whether through chemicals added to foods, through chemicals used to grow foods, through environmental toxins, or through substances injected into the body designed to trick the immune system into an exaggerated response activates the CNS microglia, and can lead to neural destruction via a number of routes. Of relevance here is that the production of cytokines (specialised immune system regulating proteins) and

other excitotoxins by chronically activated microglial cells can not only displace glutamate from the nerve synapse, where it can allow calcium to enter and damage adjacent cells, but chronic under-conversion of glutamate to GABA will also work to over-activate the microglia. On top of this, over activation prompts the microglia to produce a powerful inflammatory cytokine called prostaglandin E2, which pushes accumulated toxins from the synapse into neighbouring areas, logically leading to widespread nerve damage. This seems to be what happens in autism, but like the damage caused in multiple sclerosis, this is no reason for it not to be repaired to a greater or lesser extent given the right conditions.

The glutamate/GABA conversion in the synapse is carried out by the mitochondrial enzyme glutamate dehydrogenase (also known as L-glutamic acid decarboxylase, or GAD), the activity of which is regulated by blood sugar levels. So if our blood sugar levels remain abnormally high, through excess consumption of sugar, or through too short a period of fast from the last meal at night to the first meal of the next day, then we are probably not converting enough glutamate to GABA. Glutamate remaining in the synapse unconverted continues to excite the nerves, eventually this stress must lead to an inflammatory response, which may partly contribute to overstimulation of microglial cells. Before we start chasing our tails, and start thinking about chickens and eggs, we will take a moment to review best practice in relation to glutamate.

- try not to over stimulate the immune system
- try not to have free systemic calcium
- try not to eat too much sugar
- try to allow your blood sugar to drop naturally, and regularly

Now that isn't overly hard. There is good news to come, but for now, let's look at each point. The immune system doesn't like to be on a constant war footing. Who does? We have talked about calming the gut, and now, we need to seriously consider just how we are going to reduce the amount of toxins and other things that over-stimulate, or over-tax the immune system. We want to do this for ourselves, but most importantly: we want to do it for our children. The infant and child immune system is currently under an unsustainable level of assault, you only need to look to the children to see that.

Calcium: the biggest offender there is pasteurised milk. Pasteurisation destroys the enzyme alkaline phosphatase, which we need to absorb calcium efficiently. We can manufacture this enzyme, but often this mechanism is less than ideal. Also needed are magnesium (from food) and vitamin D, which we can get from the sun. This is why the United States can be the world's largest consumers of milk, and yet also be the nation most deficient in calcium. Culturing of milk with kefir grains restores the enzymes needed for calcium absorption. Vitamin K2, perhaps the most deficient essential nutrient in western diets, is also needed for efficient calcium absorption. K1 is found in fresh, dark leafy greens, it is also stored in the flesh and milk of animals that are 100% pasture raised, but not in the flesh or milk of grain fed, or grain finished animals. K1 is converted to K2 by an optimally functioning body, some preformed K2 occurs in greens and animal products, but LAB fermentation is the most reliable way of ensuring we get enough K2. Sauerkraut, natto, gundruk, and kefir milk made from raw (grass fed) milk are the best sources of K2 that involve fermentation. As if we need another reason to eat fresh, local, chemical free greens, this is our first stop shop for vitamin K. By supporting small, local, ethical farmers, we help support our communities, and make less contribution to the depletion, destruction and poisoning of our soils.

Try not to eat too much sugar is self explanatory, and when this is tied to the idea of an extended night-time fast, we truly allow glycogen stores in the body to be depleted before we eat again. Exercise care with children, and other

potentially vulnerable groups, but consider the idea of not eating breakfast, and extending each day's fast until 10.30 – 11.00 (at least on some days).

Some high glutamine foods are beef, pork, chicken, turkey, eggs, mushrooms, fish, milk, Parmesan cheese, nuts, beans, peas, cabbage, spinach, and parsley. But, we are not talking about reducing these (except in extreme cases), because…

Here is the good news. We can ensure we eat foods that either contain GABA (or the GABA conversion facilitator L-theanine), or that will help the body to restore natural rates of GABA conversion, and a lot of them involve fermentation. Before we continue though, a word about conflicting ideas in this area: that GABA can cross the blood/brain barrier is much disputed, and many physicians discount the efficacy of oral GABA in food, or as a supplement. Drugs have been developed that co-join GABA analogues with carriers that can facilitate transport across the blood/brain barrier, but there is no reason not to consider that the body also knows this trick. Certainly the results of some clinical trials indicate this may be the case, though of course there may be some other mechanism. One mechanism may be that when ingested, GABA acts not on the central nervous system, but on the peripheral nervous system, where it appears to inhibit perivascular nerve stimulation and noradrenaline release. Therefore, neuroexitotoxicity is assisted not directly, but indirectly through the action of overall bodily relaxation and reduction in hypertension.

There is almost universal agreement that theanine will cross from the blood to the brain quite easily, as does glutamine. In an earlier section, recall we looked at the formation of neurotransmitters in the gut, and discussed the concept of a gut/brain axis mediated through either the vagus nerve or the spinal cord. Clinical evidence supports but does not prove the existence of a gut/brain axis whereby what is in the gut affects the physiology of the brain, but then, very little is actually proven beyond doubt in science, and in medical science in

particular. All that aside, most foods mentioned here contain both GABA and theanine, and there are also other things we can eat, take, or do that will assist restoring balance to the glutamine/glutamate/GABA conversion cycle.

One of the best GABA friendly ferments is plain old kombucha, brewed with a good quality green tea, and fermented to acidity. All teas contain GABA and theanine, but fermented green tea, such as puh ehr, or when fermented with a kombucha scoby is the highest. Also high is the shaded Japanese tea called Gyokuro. A cup or two of kombucha tea daily, straight, with no sugary juice or fruit added will go a very long to restoring GABA conversion and levels as long as we are looking after the items mentioned above. Fermented oats are also a good and readily available source, simply leave organic oats in water in a covered glass bowl for 24-48 hours, then cook as normal. Note that both tea and oats are traditionally associated with relaxation, or the ability to promote relaxation in the body. In studies on fermented Korean foods, traditional kimchi and the cod gut ferment Jot-gal were both seen to increase GABA and reduce glutamate, and traditionally fermented fish in the Japanese style likewise increases GABA and theanine in the final product.

Consider switching your morning drink from coffee, to tea. The high caffeine levels in coffee elevate dopamine (an 'activating' neurotransmitter) levels substantially, whereas the low caffeine content of tea is more than offset by the GABA/theanine component of tea. As well as being GABA friendly, teas of all kinds are loaded with potent anti-oxidants, and black tea specifically contains theaflavins which work to lower total cholesterol, and to raise HDL. Whichever tea you use, the benefits are there, the only important choice is to source certified organic loose leaf teas of the highest quality, brew them weak, and take them ‘black’. They will last longer, and you will rediscover the real taste of tea.

Kefir, a powerful health drink made by fermenting milk with kefir 'grains' (symbiotic communities of probiotic bacteria and yeasts) is not only a good

GABA/theanine food, it also boosts levels of serotonin (the neurotransmitter we met earlier), the body's second most potent chemical relaxation agent. Kefir is best made with raw milk (from any animal), but if raw milk is not available or legal where you are, don't worry – kefir fermentation redresses many of the detrimental changes rendered to milk by pasteurisation, including the reconstruction of the alkaline-phosphatase and lactase enzymes. Kefir is addressed in detail in another publication.

Eat foods rich in vitamin K2, and lots of fresh leafy greens rich in vitamin K1, which can be transformed in the healthy gut to K2. An increase in greens allows for a decrease in carbohydrates in all their forms. Remembering the sugar problem, since many of us have allowed our body to rely on sugar burning for our day to day energy needs, the fate of carbs is generally to be transformed into sugar as fuel for our metabolic fire. A better source of day to day fuel, in my opinion, is good quality saturated fat. Give thought to what nutrients your food contains – essential minerals such as magnesium and zinc will not only assist with calcium absorption, they will guard somewhat against the ravages of excess glutamate. The whole range of B vitamins are also essential for good nerve health (most of us already know that), and as we have already seen, B6 in particular is required for GABA conversion. A good resource for learning nutrient dense foods and the typical nutrient contents of these foods is the website “World's Healthiest Foods”.

Other measures for favouring GABA in the body include valerian root and kava kava herbs (neither should not be taken for extended periods or at high doses, consult a herbalist if in doubt), yoga, meditation, and any process, practice or herb that contributes to general relaxation and stress relief.

In closing, if you experience any kind of adverse reaction from eating sauerkraut, and you can determine that the cause of the reaction is glutamate, then I would suggest that the reaction is a symptom, and not a cause. We should always manage symptoms in the short term of course, but ultimately,

we want to get to the root cause of any problem. Otherwise we become like rats on a wheel of adverse reaction, on and on, until we die.

Colonisation of the newborn (neonate) gut

The colonisation of the neonate gut by bacteria is pretty much the same as the succession of bacterial colonisation within a sauerkraut ferment. Enterobacter spp have recently been confirmed in utero, with mostly secondary spp picked up via passage through the birth canal, and the bulk of the more significant tertiary Lactobacillic spp. becoming available via breast milk and normal parent to child contact. Tertiary spp are found in the birth canal, but in the neonate gut they require the modification of the environment initiated by secondary spp, which in turn may only flourish after primary species have modified the environment. This modification takes the form of acidification, and creation of an anaerobic state, both of which favour probiotic organisms, and prevent overgrowth of potential pathogens.

Tradition in some parts of Europe was to give babies a little sauerkraut juice once their systems were settled. For breastfed babies, this is about 9 months, though due to the minor D-lactate content of sauerkraut, I concur with conventional medical advice, which is to wait until the infant is 12 months old. For bottle fed babies, a settled transitional state may take twice as long to develop, or it may not develop at all without intervention, especially if the infant was born by Caesarean section, or if antibiotics were employed during pregnancy, or if the neonate herself has required antibiotic treatment. This practice was believed to ensure that full colonisation takes the most desirable (natural) route. The first food Dr Natasha Campbell-McBride (developer of the GAPS protocol) recommends for infants is a little yogurt made from raw milk as soon as they start taking solid foods. Dr Campbell-McBride is also on record suggesting it is impossible to recolonise a compromised gut, which I'm afraid I have to disagree with since I have developed a protocol to do just that. Before

we look in detail at neonate microbiota acquisition, I will just mention that this preamble emphasises the need for parents to have a normal balance in their internal ecosystems prior to having children. It certainly sheds some light on why traditional healing methods for bacterial vaginosis include a pessary of either yoghurt or lacto-fermented vegetable matter to help restore the natural vaginal microbial balance. It also tells us that not all acidification is a bad thing, and indeed, one of the indicators of vaginal infection is a pH greater than 4.5.

Here is one reason we need to approach statements of cold, rigid, scientific fact with caution. Just before the end of the last century, study after study proclaimed the sterility of the foetus and placenta as unshakable truths. If swabs of a newborn's mouth and his mother's anus revealed the same serotype of *Escherichia coli*, then the only plausible explanation was seen to be contamination of the infant by the faeces of the mother. There is nothing wrong with that as a notion, and the faecal/oral route is a useful route of inter-host dispersal for many beneficial as well as pathogenic organisms. It was the application of the notion that was problematic, in that it takes an observation and hypothesis, refers it to the sausage machine of entrenched dogma, and spits out a fact at the other end. Except that we now know that the above assumption was wrong because the dogma that informed it was wrong.

Brine

Brine is salt and water. For self brining ferments such as cabbage or finely shredded radish, 5.5g per 500 g of vegetable matter will be just right.

Most firm vegetables require a 2 – 2.5% brine. Cucumbers will need from 3.5 – 5.2% and peppers and chillies as much as 10%.

The mathematical calculation for mixing brine is: volume of water in ml (1 ml of water = 1 g) multiplied by the strength of the brine desired (2% = 0.02) equals the amount of salt in grams.

To get a litre of 2% brine, fill a jug with 1000 ml. of water (1 litre), multiplying by 0.02, which equals 20, the amount of salt to add (in grams) to the water.

What this equates to a 2% brine is 5 g, or roughly 1 tsp of salt per cup (250 ml)

A handy brine table

	250 ml	**500 ml**	**750 ml**	**1000 ml**	**2000 ml**
2%	5 g	10 g	15 g	20 g	40 g
3.5%	9 g	18 g	26 g	35 g	70 g
5%	13 g	25 g	38 g	50 g	100 g
10%	25 g	50 g	75 g	100 g	200 g

Last word

No food or diet should ever be the sole means of healthcare. Always work with a qualified conventional of alternative practitioner when making changes to diet, and never cease medication or withdraw from drugs without supervision. I am not a doctor, and the information provided here is information based on what has worked for my family only. Every individual is different. This work does not constitute medical advice in any way.

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