

**A table of food types and microorganisms of concern to food safety.**

FOOD	PATHOGEN	COMMENTS	USUAL PRESERVATION SYSTEM
Raw Poultry	<a href="#"><i>Campylobacter</i></a> <a href="#"><i>Salmonella</i></a> Other pathogens could be present too.	Raw poultry will have a high microbial load, however this will be reduced on cooking. Pathogenic species will be present in many samples, therefore raw poultry should be handled with scrupulous hygiene prior to cooking.	Chilling reduces microbial growth rate. Vacuum / Modified Atmosphere packing can extend shelf life, but this increases risk of anaerobic pathogen growth (e.g. <i>Clostridium botulinum</i> ).
Raw Meat	<a href="#"><i>Campylobacter</i></a> <a href="#"><i>Salmonella</i></a> <a href="#"><i>Pathogenic E. coli</i></a> <a href="#"><i>Clostridium botulinum</i></a> poses a risk in VP/MAP products Other pathogens could be present too.	Raw meat will have a high initial microbial load, which will be reduced on cooking.	Chilling reduces microbial growth rate. Vacuum / Modified Atmosphere packing can extend shelf life, but this increases risk of anaerobic pathogen growth (e.g. <i>Clostridium botulinum</i> ).
Raw Fish and Shellfish	<a href="#"><i>Salmonella</i></a> <a href="#"><i>Vibrio parahaemolyticus/ cholerae</i></a> <a href="#"><i>Listeria monocytogenes</i></a> <a href="#"><i>Clostridium botulinum</i></a> (MAP/VP) <a href="#"><i>Histamine</i></a> (Scombrototoxin) producers Planktonic toxins (PSP, DSP, ASP) Viruses	Chemical and toxin poisoning is more relevant to cooked fish, the bacterial poisoning organisms are more applicable to ready to eat products.	Chilling reduces microbial growth rate. Vacuum / Modified Atmosphere packing can extend shelf life, but this increases risk of anaerobic pathogen growth (e.g. <i>Clostridium botulinum</i> ).
Bakery products	<a href="#"><i>Bacillus cereus</i></a> <a href="#"><i>Clostridium botulinum</i></a> (MAP/VP) <a href="#"><i>Staphylococcus aureus</i></a>	Baking should reduce the numbers of microorganisms present in a dough / batter, however it will not be sufficient to kill all microbes.	Baking will reduce the water activity and give a short, ambient shelf life. Baked products are sometimes packed in a modified atmosphere to further extend life, but this increases risk of anaerobic pathogen growth (e.g. <i>Clostridium botulinum</i> ).

Fruit and Fruit Juices	<p><a href="#"><u>Salmonella</u></a></p> <p><a href="#"><u>Listeria monocytogenes</u></a></p> <p><a href="#"><u>Pathogenic E. coli</u></a></p> <p><a href="#"><u>Mycotoxin</u></a></p>	<p>The low pH of fruit generally prevents growth from pathogenic bacteria, however there have been reports of <i>E. coli</i> growth in apple products. It is also possible for pathogens to survive without increasing in number, and this is of particular concern in unpasteurised products.</p>	<p>The low pH of these product types will extend shelf life in combination with chilled storage.</p>
Raw Vegetables / Salad / Sprouted seeds	<p><a href="#"><u>Salmonella</u></a></p> <p><a href="#"><u>Listeria monocytogenes</u></a></p> <p><a href="#"><u>Pathogenic E. coli</u></a></p> <p>Viruses</p>	<p>Microbial counts of raw vegetables are likely to vary, and washing cannot be guaranteed to significantly reduce the load. The risk from pathogenic microbes is relatively low, but they must be regularly screened for in RTE products.</p>	<p>Chilled storage will extend the shelf life. These products are sometimes packed in a modified atmosphere to further extend life, but this increases risk of anaerobic pathogen growth (e.g. <i>Clostridium botulinum</i>).</p>
Dairy Products	<p><a href="#"><u>Salmonella</u></a></p> <p><a href="#"><u>Listeria monocytogenes</u></a></p> <p><a href="#"><u>Staphylococcus aureus</u></a></p> <p><a href="#"><u>Pathogenic E. coli</u></a></p> <p><a href="#"><u>Campylobacter</u></a></p>	<p>Pasteurised products will have a lower pathogen risk than raw products. Live fermented products will have a high total count. Monitoring Enterobacteriaceae can be used as a hygiene indicator.</p>	<p>Chilling extends the shelf life of dairy products, UHT will give a long ambient shelf life.</p>
Processed Foods (RTE or to be re-heated)	<p><a href="#"><u>Clostridium botulinum</u></a> (MAP/VP chilled products)</p> <p><a href="#"><u>Salmonella</u></a></p> <p><a href="#"><u>Listeria monocytogenes</u></a></p> <p><a href="#"><u>C. perfringens</u></a></p> <p><a href="#"><u>Bacillus cereus</u></a></p> <p><a href="#"><u>Staphylococcus aureus</u></a></p> <p>V. <i>parahaemolyticus</i></p> <p><a href="#"><u>Pathogenic E. coli</u></a></p>	<p>This is a broad product grouping, therefore the organisms listed to the left will present greater or lesser concern dependent on product type. Fermented products will present a high LAB/TVC without detriment to the product. VP/MAP cooked meats can also have a high LAB count and remain unspoiled. The risk from <i>C. botulinum</i> applies to chilled MAP/VP products intended to be stored for longer than 10 days.</p>	<p>Chilling is usually the method by which shelf life is extended for this product grouping. This will act in concert with other factors such as salt levels, preservatives and packaging atmosphere to give a unique, though short, shelf life. This must be validated as being safe for each product.</p>
Dried foods to be cooked (rice/pasta, pulses/grains, herbs/spices, dried meat)	<p><a href="#"><u>Salmonella</u></a></p> <p><a href="#"><u>Pathogenic E. coli</u></a></p> <p><a href="#"><u>Staphylococcus aureus</u></a></p>	<p>Organisms of concern are spore formers or are those able to survive at low water activities. If moulds are of concern, one should be aware of the possibility of mycotoxin</p>	<p>Low water activity will limit the growth of microbes, therefore a long ambient shelf life is usually achievable.</p>

	<p><a href="#"><i>Bacillus cereus</i></a></p> <p><a href="#"><i>C. perfringens</i></a></p>	<p>formation. Cooking should eliminate vegetative pathogens, spore formers can survive to be an issue in stored product.</p>	
<p>Dried raw RTE foods (nuts, fruit, museli, herbs/spices)</p>	<p><a href="#"><i>Salmonella</i></a></p> <p><a href="#"><i>Bacillus cereus</i></a></p> <p><a href="#"><i>C. perfringens</i></a></p> <p>Aflatoxin (nuts)</p>	<p>Pathogens may be able to survive if hygiene during production is poor. TVC will be high in herbs and spices. If moulds are of concern, one should be aware of the possibility of mycotoxin formation. Generally no organisms will grow as the <math>a_w</math> is too low, but pathogen presence must be considered, as must end use of the product. Once rehydrated, growth of many contaminants could occur.</p>	<p>Low water activity will limit the growth of microbes, therefore a long ambient shelf life is usually achievable.</p>
<p>Dried heat-processed foods (breakfast cereals, crisps, confectionery, herbs/spices).</p>	<p><a href="#"><i>Salmonella</i></a></p>	<p>Bacterial spores could survive heat processes, however their growth should be limited by low <math>A_w</math>. <i>Salmonella</i> poisoning has been linked to breakfast cereals, probably due to a post-process contamination. Microorganisms can tend to survive for long periods in these low <math>a_w</math> products. Herbs and spices will have a high TVC. If moulds are of concern, one should be aware of the possibility of mycotoxin formation. Note the heat resistance of many organisms will be greater at low <math>a_w</math> values.</p>	<p>Low water activity will limit the growth of microbes, therefore a long ambient shelf life is usually achievable.</p>
<p>Dried heat-processed foods, RTE after rehydration. (Soup mixes, pot snacks, powdered milk based products).</p>	<p><a href="#"><i>Salmonella</i></a></p> <p><a href="#"><i>Staphylococcus aureus</i></a></p> <p><a href="#"><i>Bacillus cereus</i></a></p> <p><a href="#"><i>C. perfringens</i></a></p>	<p>Bacterial spores could be present in these products, therefore product safety will depend on initial load and the storage conditions after rehydration, as the raised <math>a_w</math> may allow the growth of any surviving organisms.</p>	<p>Low water activity will limit the growth of microbes, therefore a long ambient shelf life is usually achievable in dried state. The shelf life of reconstituted products will vary and must be validated if any storage is intended.</p>
<p>Dried Baby Foods (RTE after rehydration)</p>	<p><a href="#"><i>Salmonella</i></a></p> <p><a href="#"><i>Pathogenic E. coli</i></a></p> <p><a href="#"><i>C. perfringens</i></a></p> <p><a href="#"><i>Bacillus cereus</i></a></p> <p><a href="#"><i>Cronobacter sakazakii</i></a></p>	<p>Babies are more susceptible to food poisoning, therefore stricter microbiological limits are generally applied. If the product is reconstituted and held for any period of time, then the risk of pathogen growth increases.</p>	<p>Low water activity will limit the growth of microbes, therefore a long ambient shelf life is usually achievable in dried state. The shelf life of reconstituted products will vary and must be validated if any storage is intended</p>

	<a href="#"><u>Staphylococcus aureus</u></a>		
Canned, pouched or bottled food (F <sub>0</sub> >3 process)	Histamine for scombroid fish. Heat resistant bacterial toxins could occur if pre-process growth of toxin producers has occurred.	As processing is designed to effectively reduce the microbiological load to undetectable levels, testing of finished packs should involve incubation of packs followed by examination for blowing, pH change, organoleptic defects etc.)	Heat process will give an extended ambient shelf life through destruction of resident microbiological flora.
Heat treated (F <sub>0</sub> <3 process) low pH (<4.5) or intermediate moisture foods. E.g. cured meats, products in oil, pickles, sauces, jams.	<a href="#"><u>Salmonella</u></a> <a href="#"><u>Listeria monocytogenes</u></a> <a href="#"><u>C. perfringens</u></a> <a href="#"><u>Staphylococcus aureus</u></a> <a href="#"><u>Pathogenic E. coli</u></a>	Bacterial spores may be present in herbs/spices. Effective preservation is dependent on use of a validated heat process and maintaining pH and Aw throughout the product's shelf life. Some pickles / sauces may be suitable for CIMSCEE testing to give an indicator of safety and stability.	A combination of low pH, high sugar, salt and the thermal process will give some shelf life extension. This needs to be validated as being safe, CIMSCEE testing is one way of achieving this.
Non-Dairy fats and oils (cooking oil, lard, spreads)	<a href="#"><u>Salmonella</u></a> <a href="#"><u>Listeria monocytogenes</u></a>	Hot refined oils should be free from microorganisms. Cold pressed products will require monitoring. mycotoxin could be present in nut oils if original nuts supported mould growth. Correct packing and avoidance of moisture is essential.	If properly processed, packaged and stored then a long ambient-stable shelf life is achievable.
Soft and alcoholic drinks	N/A	Pathogens are unlikely to be present, especially in pasteurised products. There have been cases of food poisoning linked to unpasteurised fruit juices, so proper control of raw ingredients is essential.	Low pH is the primary method of soft drink preservation, often in combination with preservatives such as sorbates and benzoates. Alcoholic drinks are preserved through the presence of alcohol and other preservative compounds. Either can be pasteurised to improve safety and extend shelf life.