Question: What gas mixtures are best for modified atmosphere packaging (MAP) to store ready-to-eat (RTE) meat products to obtain a 2-week shelf-life and not impact quality/flavor/color?

Response: Most studies that compared different gas mixtures in MAP during storage of meat products looked at fresh meat, and those that did look at RTE meats were usually more interested in safety than quality. In general, studies in the literature found that a high (at least 30%) CO_2 concentration and an absence of O_2 seem to be the preferred MAP conditions for RTE meat products. Here are some of the key studies identified:

Reference	Meat product	MAP gas composition	Storage conditions	Results
(Stasiewicz et al., 2015)	Pre-cooked sausages in artificial protein casings	20% CO_2 + 80% N_2 50% CO_2 + 50% N_2 80% CO_2 + 20% N_2	4°C for 15 days	• The presence of carbon dioxide in modified atmosphere slowed down the rate of lipid oxidation in meat products. • The atmosphere with the highest carbon dioxide concentrations was most suitable for storing pre-cooked sausages.
(Gokoglu et al., 2010)	Beef frankfurter-type sausages	30% CO_2 + 70% N_2 70% CO_2 + 30% N_2 100% CO_2 80% CO_2 + 20% O_2	4°C for 28 days	• CO2 was effective at both inhibiting oxidation and in microbial inhibition. • The highest viable count was found in the 30% CO_2 + 70% N_2 atmosphere; the lowest with 100% CO_2. • The lowest count for lactic acid bacteria was found for the 80% CO_2 + 20% O_2 atmosphere, but this atmosphere had the lowest sensory score. • The authors concluded the best atmosphere to maximize quality and shelf-life was 70% CO_2 + 30% N_2.
(Summo et al., 2016)	Ripened sausages containing 120 mg/kg nitrate	70% N_2 + 30% CO_2 80% N_2 + 20% CO_2 95% N_2 + 5% CO_2	4°C for 5 months	• Oxidative degradation occurred less at higher CO_2 levels (probably during the initial storage period when residual oxygen from the food product was still available). • Sensory scores were better at higher CO_2 levels.
(Cachaldora et al., 2013)	Morcilla (cooked blood sausage)	15% O_2 + 35% N_2 + 50% CO_2 60% N_2 + 40% CO_2 40% N_2 + 60% CO_2	4°C for 8 weeks	• Packaging did not influence shelf life, which was greater than 8 weeks for all packaging conditions. • Samples packaged with high CO_2 (40% N_2 plus 60% CO_2) should the lowest values of TBARS (a sign of lipid oxidation) at the end of storage
(Jin and Choi, 2017)	Fermented dry-cured hams	Aerobic packaging Vacuum packaging 30% CO_2 + 70% N_2	4°C for 12 weeks	• In terms of CIE*color, TBARS, VBN, and sensory evaluation, the vacuum packaging and MAP methods better maintained the quality characteristics of fermented dry-cured hams during storage when compared with aerobic packaging. • In comparisons between the vacuum packaging and MAP methods, the values of pH, moisture and tenderness were higher, and that of salt content was lower in vacuum packaging. • Additionally, the redness value, which is regarded as a color stability criterion, and inhibition of microorganism growth were higher at the end of the storage periods for vacuum packaging vs. MAP. • The VBN value was lower for the MAP packaging method during storage.
(Naas et al., 2013)	Low-fat turkey bologna	100% CO_2 Air Vacuum	4°C for 42 days	• 100% CO_2 packaging prevented outgrowth of *Listeria monocytogenes* throughout 42 d of storage, whereas non- CO_2 packaging displayed a 2-log increase in population during storage.

Reference	Meat product	MAP gas composition	Storage conditions	Results
(Smiddy et al., 2002)	Various sliced processed cooked meats	70% N2 and 30% CO_2;	4°C for 21 days	• Although all products (25 packs each of 13 different cooked meat products from 3 different manufacturers) were all packaged with the same MAP, O_2 was present in 88% of packages within 24 hours of packaging (20% were >1.2% O_2). By day 21, 79.3% of packages contained >1.2% O_2.
(Lawlor et al., 2000)	Cooked, uncured turkey	100% N_2 30% CO_2 + 70% N_2	4, 10, and 15°C for up to 60 days	• Packaging atmosphere had no significant effect on APC. • Total aerobic populations of inoculated turkey packaged under 30% CO_2:70% N_2 were 1 to 2.5 logs lower than in inoculated turkey packaged under 100% N_2, an effect that became more pronounced as storage temperature decreased. • LAB counts were not affected by packaging atmosphere at any temperature. • The number of days until sensory unacceptability occurred was in some cases the same for the two gas compositions; no consistent influence of gas composition on sensory unacceptability was apparent.

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