The effect of CO_2 and N_2 Modified Atmosphere Packaging on the spoilage of raw diced chicken breast meat stored at 4°C.

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Introduction

In 2012, the UK disposed of 110,000 tonnes of avoidable poultry waste, often as a result of expired date labels. This avoidable waste has a negative impact on the economy but also the environment contributing to green house gas emissions.

Therefore, there is a need to effectively control microbial growth to extend shelf life within the poultry industry.

Modified Atmosphere Packaging (MAP) in synergy with refrigeration has been identified as a successful method to reduce microbial growth permitting an increase of poultry shelf life of up to 25 days (Patsias et al., 2008), thus permitting an avoidable poultry waste reduction.

Microbial growth is directly dependent on available gas, the aerobic micro flora of poultry must thus be considered when creating a MAP atmosphere.

Consequently, there is a need to explore the ability of CO_2 and N_2 MAP compositions in inhibiting aerobic microbial growth and the potential for extending the shelf life of diced skinless chicken breast stored at 4°C.

Aim

This study explores the bacteriostatic properties of CO_2 MAP in inhibiting aerobic microbial growth and compares the efficacy of four modified atmosphere treatments to enable shelf life extension of diced skinless chicken breast stored at 4°C.

Methods

Diced, skinless chicken breast (20g) were packaged in four MAP treatments (T1 - 80:20 CO_2:N_2, T2 - 60:40 CO_2:N_2, T3 - 40:60 CO_2:N_2 and T4 - 20:80 CO_2:N_2) as well as a control (T0) in aerobiosis. Treatments were stored at 4°C, Total Viable Count (BS EN ISO 4833:2003) and pH were analysed over a predetermined period of 12 (0,5,7,12) and (0,5,7,9,12,19,21 and 24) 24 days respectively for each treatment (n=32). Statistical analyses were undertaken using IBM SPSS statistics 20.

Findings

Findings from this study have confirmed that the utilisation of high (>80%) CO2 MAP is successful in reducing the microbial growth of poultry. Table 1. highlights the growth rate; the aerobic microorganism growth per day and the generation time; the time taken for the population to double per treatment. The lower the growth rate and the higher generation time, the more effective the treatment is in reducing the aerobic microbial growth over life (Ray and Bhunia, 2014). Table 1 outlines T1 as the treatment with the lowest growth rate (6.404) and highest generation time (1.407) second to T3 6.528 and 1.380 respectively. T2 and T4 carry a growth rate above and generation time below T0.

Treatment	Growth Rate (days)	Generation Time (days)
T0	7.924	1.137
T1	6.404	1.407
T2	8.613	1.046
T3	6.528	1.380
T4	8.445	1.067

Table 1. *TVC growth rate and generation time (days) for each MAP treatment ((T0) Aerobiosis, (T1) 80:20 CO_2:N_2, (T2) 60:40 CO_2:N_2,(T3) 40:60 CO_2:N_2, T4 20:80 CO_2:N_2).*

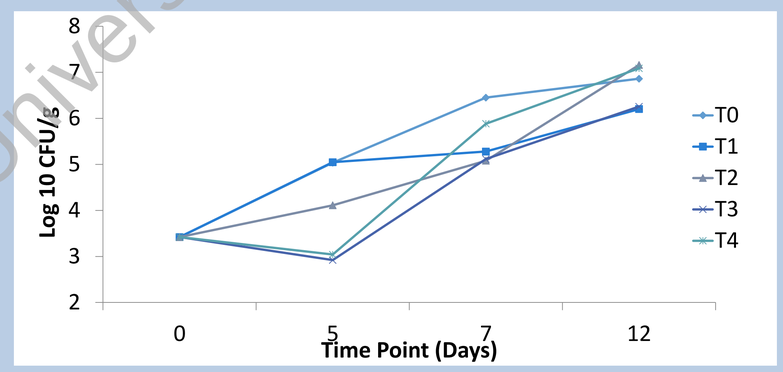

Figure 1. *TVC log_{10}CFU/g per treatment over a shelf life of 12 days. (T0) Aerobiosis, (T1) 80:20 CO_2:N_2, (T2) 60:40 CO_2:N_2,(T3) 40:60 CO_2:N_2, T4 20:80 CO_2:N_2.*

In comparison to all other tested treatments, T1 demonstrates the highest generation time and growth rate, outlining a treatment which reduces microbial growth over life (Ray and Bhunia, 2014). This conforms with existing literature where atmospheres with predominant CO_2 have improved microbial inhibitory effects (Nehlawi et al., 2013; Pastias et al., 2008; Saucier et al., 2000) in that the higher the CO_2 concentration, the higher the inhibition of aerobic microbial growth (Nehlawi et al., 2013; Pastias et al., 2008; Saucier et al 2000).

It was determined T0 (aerobiosis) did not support the fastest microbial growth (Table 1), stating a growth rate below and a generation time above T2 and T3. This resonates with Byrd et al (2011) confirming that microbial load is directly reliant on gas composition as in direct comparison to aerobiosis (T0) MAP produces a product with a lower microbial load.

Figure 1 express' the evolution of aerobic colony counts across each MAP treatment over a shelf life of 12 days. The initial aerobic contamination of raw skinless diced chicken breast (0d) was 3.42 log_{10} CFU/g. As highlighted in Figure 1, after 12d storage at 4°C, MAP treatments T1 and T3 ($\geq$ 40% CO_2) presented the lowest aerobic microbial growth (6.201 and 6.255 log_{10} CFU/g respectively). Chouliara et al., (2007; 2007a) resonates with these findings, concluding MAP samples with a higher concentration of CO_2 (70%) achieved a longer shelf life (14 - 15d) than MAP with a CO_2 concentration of 30% (11-12d).

Conclusion

In confirmation with existing literature, MAP with increased (>80%) CO_2 concentrations in diced skinless poultry breast at 4°C is successful in reducing the aerobic microbial load of poultry over life (Chouliara et al., 2007; Patsias et al., 2008) and should thus be used over an aerobic atmosphere to increase poultry shelf life in turn reducing avoidable poultry waste within industry. After 12d storage at 4°C all treatments fall outside the limits of the process hygiene requirements (10^6 log_{10} CFU/g) as laid down by the French government (Fraqueza and Barreto, 2009) highlighting the scope for further research in this area over an extended shelf life (>12d).

It is generally concluded that MAP has a positive effect on the shelf life of chilled poultry, however research within this area is widely incomparable due to product variance, refrigeration temperatures and microbial guidance limits. As a result of this, there is reason to conduct further research within this field, to fully understand the extension of shelf life on raw skinless chicken breast, microbiological analysis to monitor the growth of both aerobic and anaerobic bacteria is required.

References

Byrd, J. Sams, A. Hargis,B and Caldwell,D. (2011). Effect of Selected Modified Atmosphere Packaging on Campylobacter Survival in Raw Poultry. Poultry Science Association Inc.. 90, 1324 - 1328.
Chouliara, E., Badeka, A., Savvaidis, I., Kontominas, M.G. (2007). Combined effect of irradiation and modified atmosphere packaging on shelf life extension of chicken breast meat: microbiological, chemical and sensory changes. Eur. Food Res. Technol. 226, 877–888.
Nehlawi,A. Saldo,J. Vega, L and Guri,S. (2013). Effect of High Carbon Dioxide Atmosphere Packaging and Soluble Gas Stabilization Pre - Treatment on the Shelf Life and Quality of Chicken Drumsticks. Meat Science. 94, 1-8.
Patsias, A, Badeka, V, Savvaidis, I, Kontominas , M. (2008). Combined effect of freeze chilling and MAP on quality parameters of raw chicken fillets. Food Microbiology. 25 (.), 575 - 581.
Ray,B and Bhunia,A (2014), Fundamental Food Microbiology. 5th ed. Boca Raton: CRC Press. 54-57.
Saucier,L, Gendron, C and Gariepy, C. (2000). Shelf Life of Ground Poultry Meat Stored Under Modified Atmosphere. Poultry Science. 79, 1851 - 1856.