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Sensing the cold chain breakdown in frozen meat supply chain (#201)

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Introduction

Global meat consumption is increasing because of change in lifestyle, increase in per capita income and increasing health awareness. The consumer is more concerned about the quality of the product along with its price. Because of increasing consumption pattern, meat is transported over long distances in order to fulfil the market demand. Chicken meat is available in the form of fresh, frozen as well as ready to cook product in supermarkets. Consumer generally procures the product on the basis of on package-best before/expiry date. As chicken meat is high in its nutritional content and is perishable, it is likely to lose its quality due to fluctuation in storage temperature as well as improper handling. As far as perishable commodities like meat and meat based foods are concerned, the most demanding factor is the control of temperature throughout supply chain. Any fluctuation in temperature at any point during transport and subsequent storage will lead to decreased acceptance of the product or complete rejection due to the deteriorative changes that develops as a result of temperature abuse. Due to fluctuation in temperature, there is not only chances of rejection but sometimes leads to food safety hazards. An efficient system that can monitor any change in predetermined temperature throughout the supply chain or a system that can detect exposure of meat above a particular temperature is not available currently in developing countries. So the present study was proposed to develop a Time-Temperature Indicator (TTI) to monitor the temperature abuse of frozen chicken meat and to relate its quality and safety changes with the response of the TTI.

Methods

Various levels of substrate (guaiacol) and enzyme (laccase) concentrations were standardized before the preparation of ready to use TTI. The TTI was dependent on the amount of substrate, enzyme activity and exposure to different temperature abuse conditions. Temperature abuse conditions were simulated in the freezer. Freezer was subjected to power failure for a considerable time period so that internal temperature of frozen chicken meat (-18±1°C) reaches 0±1°C, 5±1°C and 10±1°C. One control sample was kept at -18±1°C. Once the frozen meat reached the thawing temperatures the samples were drawn immediately for analysis of various quality parameters. The meat samples were also refrozen to -18±1°C after exposing to various temperature abuse conditions.

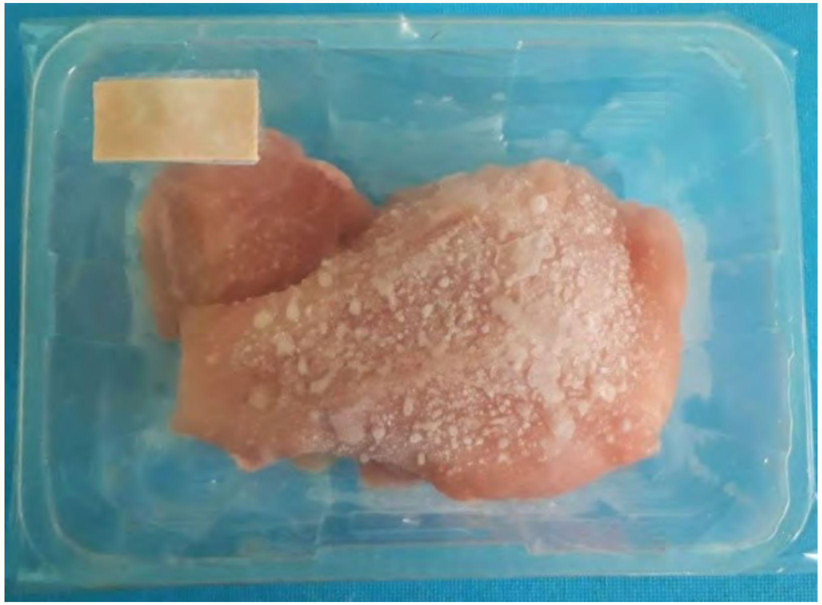
Results

The ready to use TTI showed a gradual colour change from its initial colourless to a final dark brown colour when subjected to different temperature abuse conditions. The TTI colour response at different temperature abuse conditions were compared with a control TTI kept at -18±1°C. The frozen chicken meat sample thawed up to an internal temperature of 0±1^{0}C, attached with TTI showed a initial colourless to light brown colour. As the thawed meat was refrozen, the colour of the TTI in thawed refrozen meat sample remained light brown colour that indicates that the colour response of TTI was irreversible. At 5±1^{0}C, the colour of the TTI changed to brown colour and remained brown during subsequent refreezing. At 10±1^{0}C, the colour of TTI turned to dark brown colour and remained dark brown at subsequent refreezing. In the control group, the frozen chicken meat sample was stored at -18±1^{0}C, wherein no colour change was observed. The activation energy of developed enzymatic TTI was 47.16 kJ/mol. Temperature abused frozen chicken meat samples showed a significantly ($P<0.05$) higher pH, drip loss and TVBN content than control sample. But the ERV value showed a significantly ($P<0.05$) lower value in temperature abused frozen chicken meat samples compared to control. Temperature abused frozen chicken meat samples showed a significantly ($P<0.05$) lower lovibond tintometer lightness (L), redness (a) and colour difference (ΔE) units, compared to control. But the yellowness (b) showed a significantly ($P<0.05$) higher value in temperature abused frozen chicken meat samples than control sample. The total plate count of temperature abused frozen chicken meat samples showed a significantly ($P<0.05$) higher value than control sample. But the psychrophilic and yeast and mold count of the frozen chicken meat samples did not differ significantly (P■0.05) when exposed to temperature abuse conditions. Temperature abused frozen chicken meat samples showed a significantly ($P<0.05$) lower appearance score, colour score and odour score compared to control sample. There was no sliminess observed in any groups.

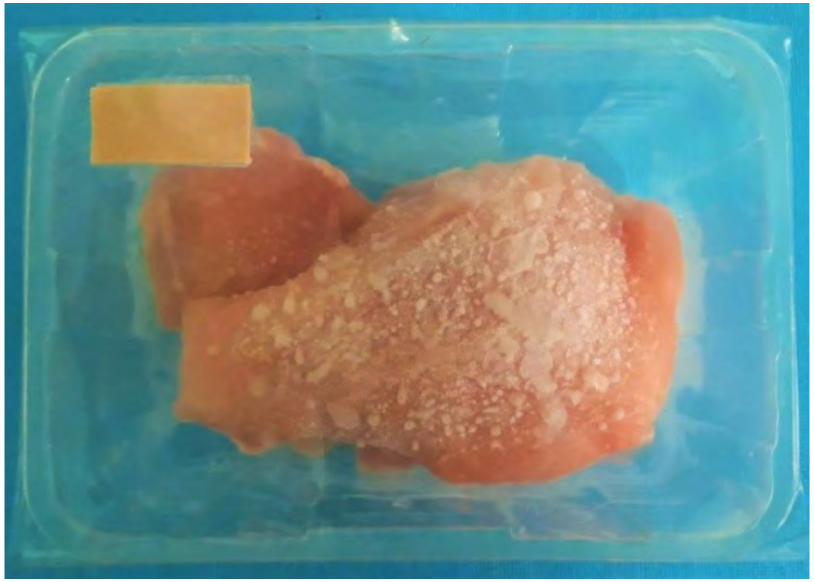
Conclusion

The colourless TTI indicated that there was no temperature abuse to frozen meat, colourless to light brown indicated that the meat was thawed mildly, light brown to brown indicated a moderate thawing, while a final dark brown indicated that the frozen chicken meat was extremely thawed.

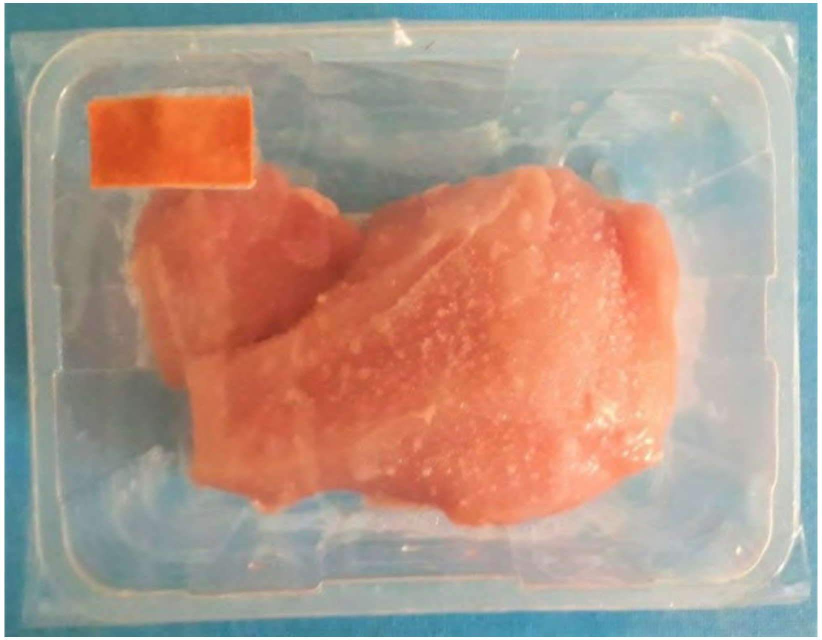
Notes



Chicken meat & TTI at 0±1 degree C



Chicken meat & TTI at 5±1 degree C



Chicken meat & TTI at 10±1 degree C

Notes