

The impact of freezing conditions on the quality of cod fillets (*Gadus morhua*)

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I. INTRODUCTION

Freezing is an efficient method of preservation of fresh fish; however, final quality depends on the initial conditions of raw material, as well as other factors during freezing process and frozen storage, including temperature and rate of freezing. In the fish processing industry, freezing of fillets of white fish is commonly used, particularly of cod. The freezing process affects changes in odour, flavour, colour, texture, water holding capacity, on which influence they have, among others, effects of ice crystals growth in muscle tissue [Dawson *et al.* 2018]. „Slow” freezing process results in the formation of large ice crystals, mainly in the intercellular spaces of the tissue, while „rapid” freezing process results in the formation of a lot of fine crystals uniformly distributed in the muscle tissue. The aim of the study was an experimental evaluation of the influence of temperature and rate of the freezing process on the quality of cod fillets.

II. MATERIAL AND METHODS

The material for study was the cod fillets (*Gadus morhua*) obtained from catches in the Baltic Sea. The fresh, cooled cod fillets (n=40 fillets in each test) were frozen individually in sealed polyethylene bags at temperature range: -18.0÷-25.0°C in a single-compressor freezer (method „A”; freezing rate 1.1°C/h) and -25.0÷-40.0°C in a two-compressor freezer (method „B”; freezing rate 5.6°C/h) for 10 days (Photo 1, Fig. 1). Then the cod fillets were thawed at +2.0°C and next were acclimated to +18.0°C before being analyzed.



Photo 1. Cod fillets with thermocouples

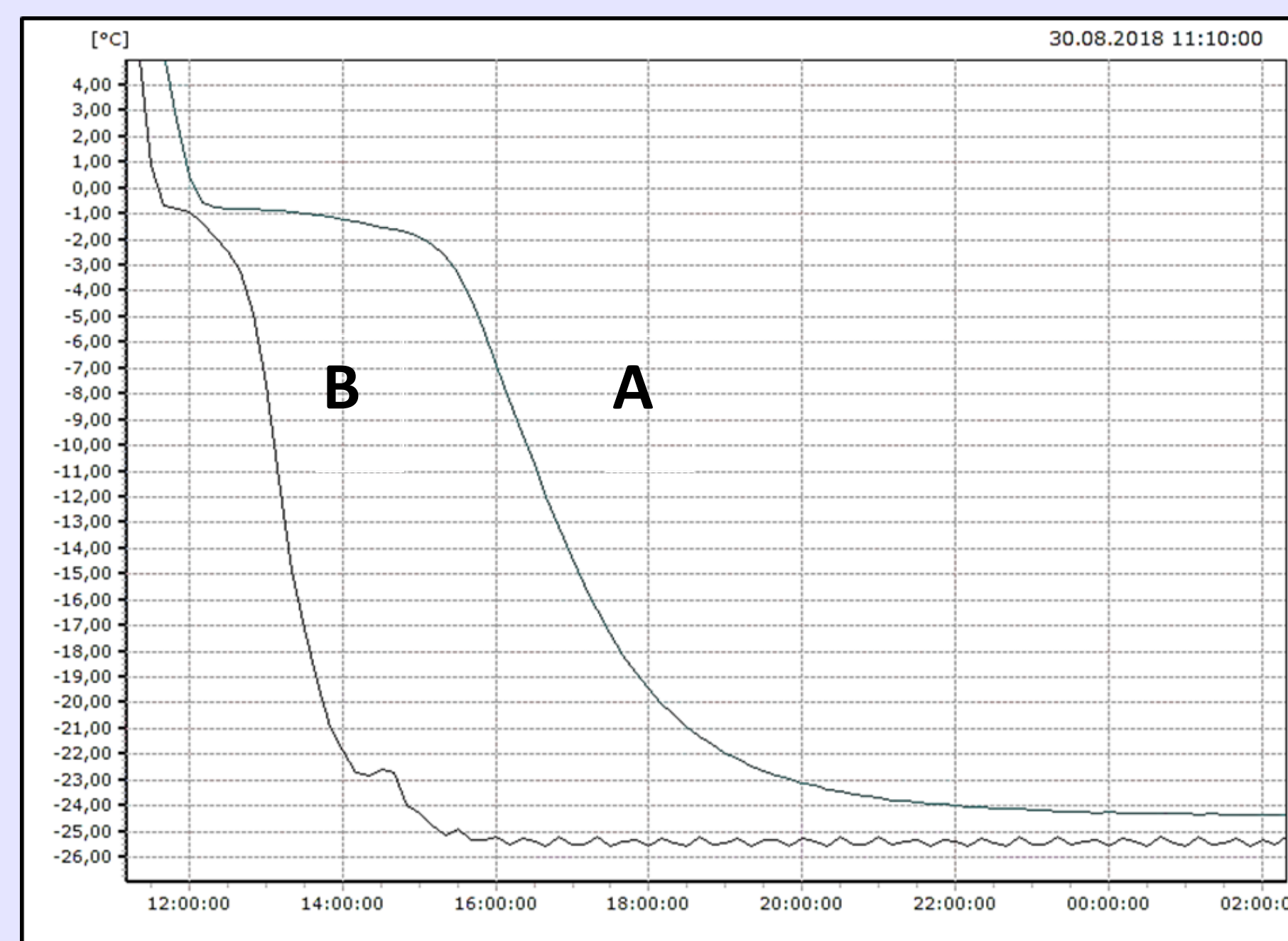


Fig. 1. Freezing process of cod fillets at -25.0°C: method „A” and method „B”

The sensory quality of cod fillets was assessed using the Quality Index Method (QIM). Raw cod fillets were analysed according to the methodology developed by Bonilla *et al.* [2007]; and frozen cod fillets according to the methodology developed by Warm *et al.* [1998]. The following sensory quality attributes were assessed: odour, colour, texture, flavour, blood stains and gapping. Weight loss during thawing was calculated as follow: $100\% \times (\text{IFW} - \text{TFW}) / \text{IFW}$, where IFW is the initial fillet weight after filleting, and TFW is the weight of the thawed fillets. Liquid leakage during freeze-chill store for 3 days thawed cod fillets was calculated as $100\% \times \text{weight increase of the pad (g)} / \text{initial muscle weight (g)}$ [Mørkøre and Lilleholt, 2007].

III. RESULTS

The results has shown that the sensory quality and selected physical indicators of frozen fillets depended on the temperature and rate of freezing. Fillets frozen at temperatures -18.0÷-25.0°C (method „A”) were characterized by lower sensory quality compared to fillets frozen at temperatures -25.0÷-40.0°C (method „B”). QI scores of thawed, raw fillets frozen at -18.0 ÷-25.0°C (method „A”) were in the range of 5.9÷7.2 pt, while the QI scores of fillets frozen at -25÷-40°C (method „B”) were in the range of 4.6÷5.5 pt. On the other hand, the sensory quality of fillets frozen at temperature range: -25.0÷-35.0°C (method „B”) was higher than sensory quality of fillets frozen at temperature -40.0°C in the same method (Fig. 2). Weight loss during thawing of fillets (Fig. 3) were lower in fillets frozen at temperature range: -25.0 ÷-40.0°C (method „B”) and were in the range of 2.5÷2.9%, than in fillets frozen at temperature range: -18.0 ÷-25.0°C (method „A”) and were in the range of 5.8÷7.5%. Also, weight loss during chilled storage of fillets (Fig. 4) frozen at -25.0÷-40.0°C (method „B”) were in the range of 5.0÷5.7%, while weight loss during thawing of fillets frozen at -18.0 ÷-25.0°C (method „A”) were in the range of 8.1÷14.9%.

IV. CONCLUSIONS

Achieving high quality frozen fish fillets requires the application of optimal methods and parameters, including temperature and rate of the freezing process. The study showed that in the case of cod fillets, the highest quality (high sensory quality and low weight losses during defrosting) was obtained by frozen fillets at the temperature range -25.0÷-35.0°C using method „B” (two-compressor freezer).

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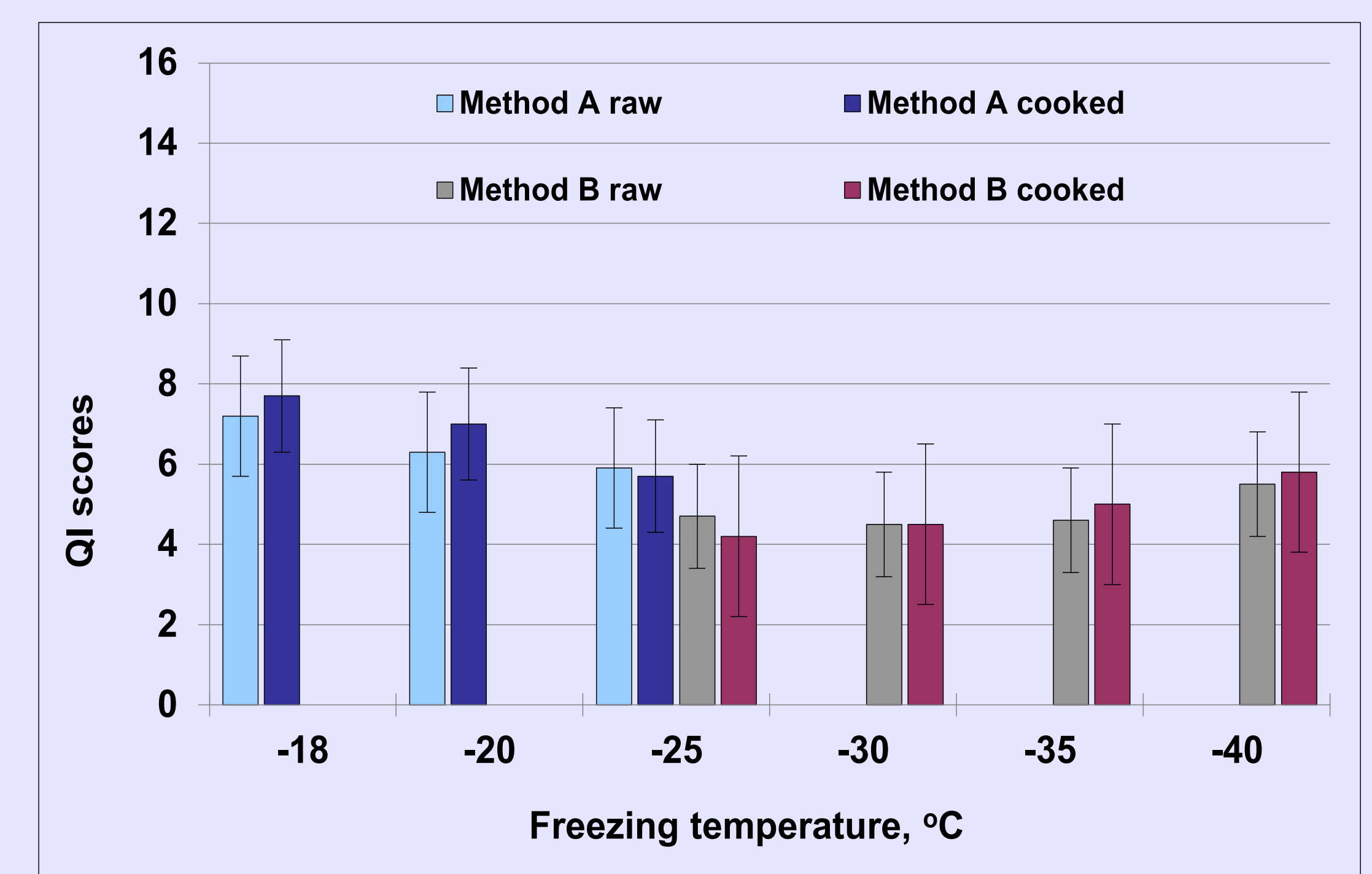


Fig. 2. QI scores of thawed cod fillets depending on the temperature and rate of freezing

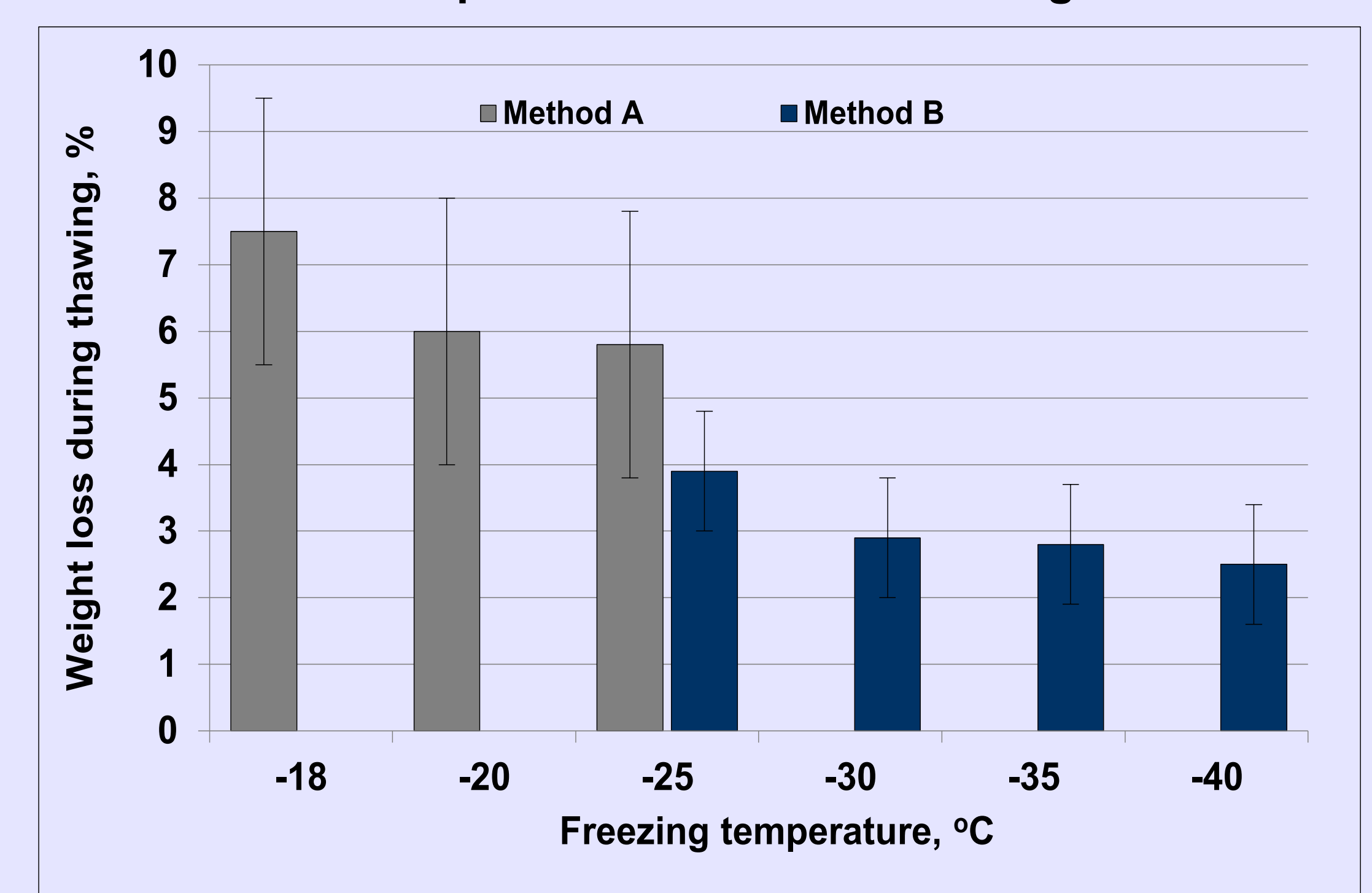


Fig. 3. Weight loss during thawing of cod fillets depending on the temperature and rate of freezing

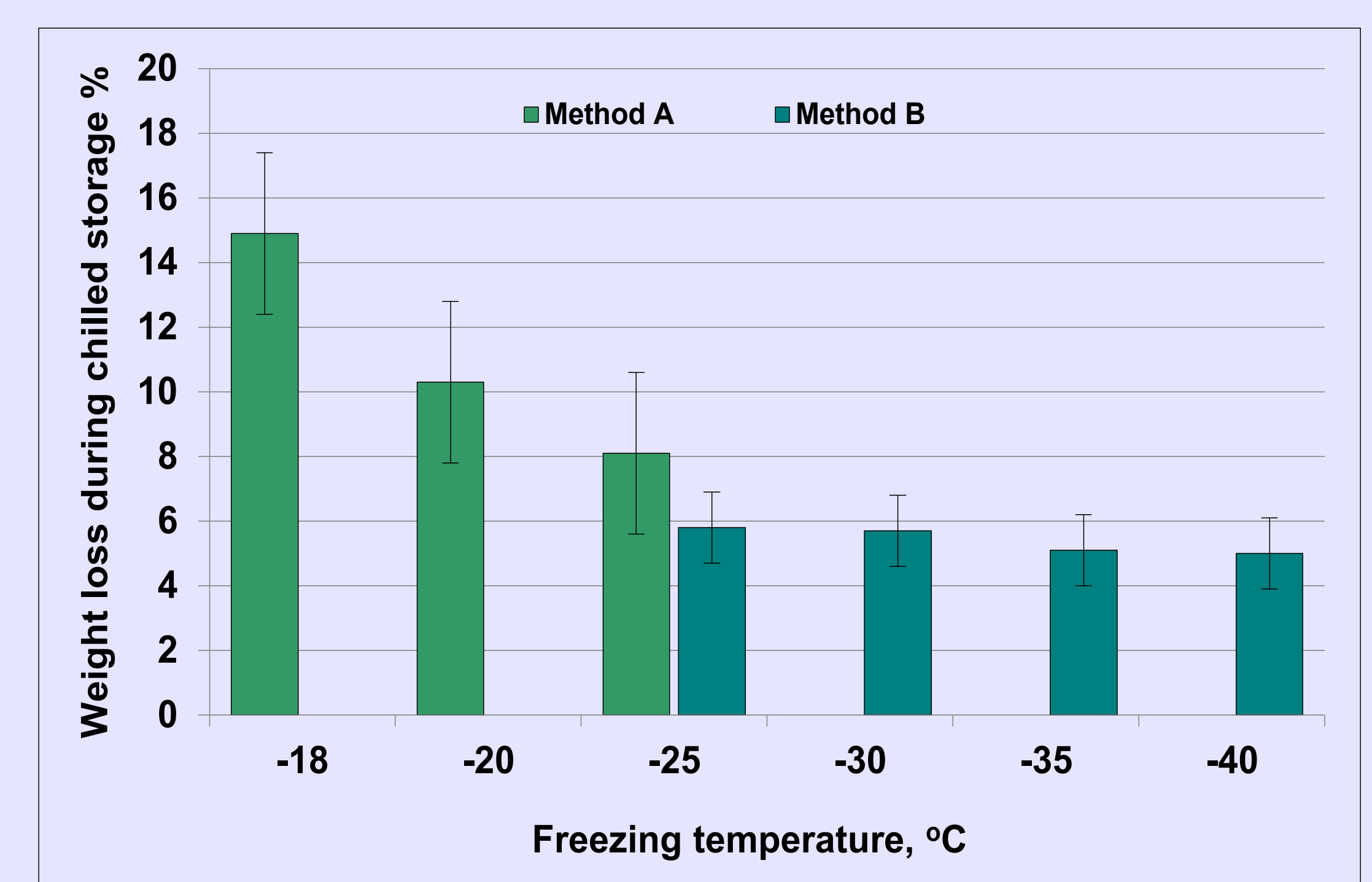


Fig. 4. Weight loss during chilled storage of cod fillets depending on the temperature and rate of freezing

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