Technical Report

ISO/TR 23016-5

Fine bubble technology — Agricultural applications —

Part 5: Practical data collection to promote the germination of typical vegetable seeds using ultrafine bubbles

Technologie des fines bulles — Applications agricoles —

Partie 5: Collecte de données pratiques pour favoriser la germination de graines de légumes types par l'utilisation de bulles ultrafines

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 281, *Fine bubble technology*.

A list of all parts in the ISO 23016 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The market for technologies using fine bubbles has been rapidly growing in many applications throughout the industrial, domestic, and academic sectors. Especially, the application of ultrafine bubble (UFB) technology to the agricultural area is arousing great interest. It is thought to be one of the advanced technologies improving the productivity and efficiency of agriculture, thereby contributing to the United Nations Sustainable Development Goals (SDGs) by means of providing sufficient food and maintaining water resources on land, as an example.

In this context, ISO 23016-2:2019 has been published, describing the test method for promoting barley seed germination by application of a UFB water generation system. Although the promotion of germination of barley seed is closely related to UFB number concentration, effects of the concentration were not specified at that time.

Thus, in order to provide users with a guideline for selecting an appropriate UFB generation system, ISO/TR 23016-3:2021 has been published to indicate the minimum viable number concentration of ultrafine bubbles that promotes the germination of barley seeds.

Furthermore, based on the continual accumulation of data revealing positive and negative effects of UFB on germination depending on the variety of barley seeds, ISO 23016-4 has been published to provide a method to evaluate the UFB number concentration ensuring the promotion of germination of the barley seeds without taking into account their varieties.

This document describes the data collected from the experimental observations on applying UFB water to promote the germination of vegetable seeds, based on ISO 23016-2, ISO/TR 23016-3 and ISO 23016-4. It was developed to support the application of the UFB technology to vegetables specially grown in hydroponic culture system, which market is quite large and still growing.

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Fine bubble technology — Agricultural applications —

Part 5: Practical data collection to promote the germination of typical vegetable seeds using ultrafine bubbles

1 Scope

This document provides practical data collection of promoting the germination of typical vegetable seeds by applying ultrafine bubbles (UFBs) within the effective number concentrations for barley seeds specified in ISO 23016-2, ISO/TR 23016-3 and ISO 23016-4. While the application of UFB to barley seeds is systematically standardized, reports on UFB application to vegetable seeds germination are scattered worldwide. Therefore, this document intends to illustrate the effectiveness of UFBs to promote the germination of vegetable seeds depending on their response to light, i.e.:

a) require light to germinate (positive photoblastic),

b) require darkness to germinate (negative photoblastic), and

c) neutral to light[1].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 23016-2, *Fine bubble technology — Agricultural applications — Part 2: Test method for evaluating the promotion of the germination of barley seeds*

ISO/TR 23016-3, *Fine bubble technology — Agricultural applications — Part 3: Guidelines for the minimum viable number concentration of ultrafine bubbles for promoting the germination of barley seeds*

ISO 23016-4, *Fine bubble technology — Agricultural applications — Part 4: Test method for evaluating the number concentration of ultrafine bubbles (UFB) achieving the promotion of barley seed germination*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 23016-2, ISO/TR 23016-3 and ISO 23016-4 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Test subjects

The items subjected to the test are air UFB water stored in bottles or other containers for preservation and transport in accordance with ISO 21255, and the UFB generating system used to generate the UFB water.

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