

ISO/DTR 23016-5

ISO-/TC-281/~~AWG~~

Secretariat: JISC

Fine bubble technology

Agricultural applications

Part-5:

Practical data collection ~~of promoting to promote~~ the germination of typical vegetable seeds using ultrafine bubbles

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Contents

Foreword	vii
Introduction	viii
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Test subjects	2
5 Judgement of significant difference in T_{50}	2
6 Seeds and measurement device	2
6.1 Seeds for germination test	2
6.2 Measurement device for UFB size and concentration	2
6.3 Examination range of UFB number concentration for vegetable seeds and adjustment of dissolved oxygen concentration (DO)	2
7 Test data	3
7.1 General	3
7.2 Carrot seeds of positive photoblastic	3
7.3 Tomato seeds of negative photoblastic	5
7.4 Spinach seeds of neutral photoblastic	6
7.5 Effect of DO (Dissolved oxygen concentration)	8
7.6 Effect of UFB number concentration	9
7.7 Presence or absence of seed size effect on the promotion by UFB	11
7.7.1 General	11
7.7.2 Carrot seed of comparatively large size	12
7.7.3 Carrot seed of comparatively small size	13
8 Suggestion	15
Annex A (informative) Example of measured UFB data of size distribution and number concentration of UFB used in this document	16
Annex B (informative) 95 % confidence intervals of T_{50} values corresponding to Figures 1 to 7	20
Bibliography	32
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Test subjects	1
5 Judgement of significant difference in T_{50}	2
6 Seeds and Measurement device	2

6.1 Seeds for germination test.....	2
6.2 Measurement device for UFB size and concentration.....	2
6.3 Examination range of UFB number concentration for vegetable seeds and adjustment of DO.....	2
7 Measurement data.....	2
7.1 General.....	2
7.2 Carrot seeds of positive photoblastic.....	3
7.3 Tomato seeds of negative photoblastic.....	4
7.4 Spinach seeds of neutral photoblastic.....	5
7.5 Effect of DO (Dissolved oxygen concentration).....	6
7.6 Effect of UFB number concentration.....	7
7.7 Presence or absence of seed size effect on the promotion by UFB.....	8
7.7.1 General.....	8
7.7.2 Carrot seed comparatively large size.....	8
7.7.3 Carrot seed comparatively small size.....	9
8 Suggestion.....	11
Annex A (informative) Example of measured UFB data of size distribution and number concentration of UFB used in this technical report.....	12
Annex B (informative) 95% confidence intervals of T_{50} values corresponding to Figure 1 to 6.....	14
Bibliography.....	21

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Foreword

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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 ~~documents~~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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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 ~~have~~has been rapidly growing in many applications throughout the industrial, domestic, and academic sectors. Especially, ~~application of ultrafine bubble (UFB) technology to the agricultural area~~ are arousing great interest, ~~because it. It is thought that they are the part to be one~~ of the ~~advanced technologies~~ improving the productivity and efficiency of agriculture. ~~Consequently, this is in line with the promotion of, 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 the light of the current situation above~~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~~ in it ~~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 ~~a positive/ and negative effect~~effects of UFB on germination ~~appears~~ depending on the variety of barley ~~seed~~seeds, ISO 23016-4 has been published to provide a method to evaluate the UFB number concentration ~~assuring~~ensuring the promotion of germination of the barley seeds without taking into account their varieties.

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

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Fine bubble technology — Agricultural applications

Part 5: Practical data collection of promoting 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. ~~As mentioned in the previous sentence, While~~ the application of UFB to barley seeds is systematically standardized. ~~However,~~ reports on UFB application to vegetable seeds germination are scattered worldwide. ~~Thus/Therefore,~~ this document ~~illustrates/intends to illustrate~~ the effectiveness of UFBs to promote the germination of vegetable seeds ~~of which responses depending on their response to light are (a) , i.e. require light to germinate (positive photoblastic), (b) require darkness to germinate (negative photoblastic) and (c) neutral to light [1].~~

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 ~~referenced document is indispensable for documents are referred to in the application text in such a way that some or all of their content constitutes requirements~~ of this document. For dated ~~reference~~ 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 terminological databases for use in standardization at the following addresses:
— ISO Online browsing platform: available at <https://www.iso.org/obp>
— IEC Electropedia: available at <http://www.electropedia.org/>~~

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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 ~~to~~with ISO-21255, and the UFB generating system used to generate the UFB water. UFB water is generated by supplying raw water to the UFB generating system. Distilled water with a quality of Grade 2 ~~in accordance to~~ ISO 3696 or greater is used as raw water that is distilled water supplied as a raw material for both UFB water and control water according to ~~the Clause 3.6 of~~ISO 23016-2-:2019, 3.6.

The size, quantity and concentration of UFB in UFB water were measured ~~and examples.~~ Examples of measured data are given in ~~Annex A.~~ Annex A.

6.5 Judgement of significant difference in T_{50}

After determining the correlation curve ~~by Formula (2) in accordance to using~~ ISO 23016-2-:2019, Formula (2), the sum squared of residual (SSR) and standard error (SE) around the time T_{50} are calculated. From this curve, the 95-% confidence interval of T_{50} is determined. The results are shown in ~~the figures~~Figures B.1 to B.7 in Annex B.

7.6 Seeds and ~~Measurement~~ measurement device

7.16.1 ~~6.1~~ Seeds for germination test

~~Vegetable~~The following vegetable seeds of ~~which different~~ responses to light ~~are as follows:~~ (a) ~~were used as the seeds for the germination test:~~

- a) ~~require light to germinate (positive photoblastic),~~ (b)
- b) ~~require darkness to germinate (negative photoblastic),~~ and (c)
- c) ~~neutral to light (neutral photoblastic) [1] are used as the seeds for the germination test.]¹⁾~~

It is not necessary ~~for to rinse~~ the seeds ~~to be rinsed~~ in water ~~for before~~ use; the test is initiated using the dry seeds as supplied. The germination test was conducted at the constant temperature of 25-°C.

7.26.2 ~~6.2~~ Measurement device for UFB size and concentration

The UFB generating system is capable of supplying the UFB water described in ISO 23016-2. The air UFB water samples had their size and concentration measured using a particle tracking analysis instrument (see ISO-19430:2016). The size, quantity and concentration of UFB in UFB water were measured. ~~Measuring temperature was~~ Measurements were carried out at a room temperature around 22-°C.

7.36.3 ~~6.3~~ Examination range of UFB number concentration for vegetable seeds and adjustment of dissolved oxygen concentration (DO)

As the UFB generation system given in ISO 23016-2 stably generates UFB in the number concentration ranges from 10^7 -/ml, 10^8 -/ml and greater, the UFB in the range from 10^7 -/ml to 10^8 -/ml was applied to vegetable seeds to ~~assure ensure~~ the effect of germination promotion. ~~The air UFB number concentration in this range is known to be within the range being able to that can~~ be measured by the commercially available ~~measurement device mentioned in~~ 6.2-6.2.

Although an example of size distribution and number concentration of UFB used for barley seed germination is given in ~~Annex A of~~ISO/DTRTR 23016-3:2021, Annex A, this ~~is the case of~~ illustrates small-scale fluctuation. In this ~~technical report document,~~ examples with fluctuation to some extent are shown in ~~Annex A, that is,~~