EXTRACT PREDICTION FORMULAE BASED ON HULL PERCENTAGE AND NITROGEN OR PROTEIN CONTENT AS A TOOL IN BARLEY BREEDING*

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INTRODUCTION

Extract percentage, a measure of total solids rendered soluble during the mashing process, is one of the principal quality criteria of malted barley. Barley has always been one of the most important crops in Israel; it is grown principally in the semiarid southern part of the country, including the Negev. Varieties traditionally grown in Israel are all of the feeding type, six- or two-rowed (the so-called "rigidum" (7) group); they are widespread in all Mediterranean countries and characterized by low extract percentage. With the development of a local brewing industry, the problem of growing malting barley has become of great practical importance.

In the last few years, European two-rowed barley varieties of the "tenerum" (7) group, bred for brewing purposes, were successfully introduced into the northern, relatively high-rainfall area of the country. So far, attempts at growing them in the main producing area, in the south, were in most cases disappointing. In order to overcome this difficulty a breeding program was started, aimed at combining the good technological properties of the European "tenerum" varieties, with the adaptation of the "rigidum" barleys to the climatic conditions of the semi-arid and arid regions.

In a breeding scheme in which the parents differ greatly in extract yields, much diversity of this trait is expected in the progeny of a cross. The breeder is therefore most interested in discarding the low-extract segregates as soon as possible. In order to enable him to do so, a relatively simple, rapid and inexpensive method, feasible on small samples, is needed.

Methods based on direct extract determination of small micromalted barley samples are in most cases very reliable, and their

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results are closely correlated with standard procedures. However, they are relatively time-consuming, and often necessitate expensive facilities, which are not always available to the breeder. In most of these methods, relatively large samples are necessary. In addition, since in the Mediterranean countries barley is sown in the autumn and harvested in May, all laboratory determinations have to be carried out during the summer, in order to screen the breeding lines before sowing time. Unfortunately, the high room temperatures prevailing in this season in Israel make micromalting impossible without special facilities.

An alternative solution is to use an extract prediction method based on grain characteristics, which are easy to measure.

Bishor (1) calculated formulae of extract prediction based on variety constants, but they are not applicable in breeding work, in which the variety constant is unknown. The same author (3) therefore proposed another formula, independent of variety, and based on nitrogen and insoluble carbohydrate content of the barley grains. These formulae were often criticized, since the results are not identical to those obtained with the conventional extract determination method in the malt.

Nevertheless, in the early stages of breeding, a formula of extract prediction, ensuring results closely correlated with the direct determination method, is a very useful tool for discarding poor quality material and choosing lines for further breeding. This formula should be based on simple components, which can be determined rapidly on very small samples of grains.

The aim of this investigation was to build a new formula of extract prediction based on even simpler components than those used by previous investigators. In this work, various grain characteristics were examined and the correlation coefficients between these characteristics and extract percentages were calculated. In accordance with these data formulae of extract prediction were proposed.

**Materials and Methods**

Laboratory tests were carried out on samples of established barley varieties (see Appendix) and on segregating material of a Proctor × Brandon cross. One-kg samples of grains were taken from each of the replications of the barley trials carried out in 1962/63 and 1963/64, at different locations: Bet Dagan (Coastal Plain), Newe Ya'ar (Esdraelon Valley), En Dor (Lower Galilee) and Gilat (Negev; 1962/63 only). The varieties examined were of both the tenerum and rigidum groups. Samples of only 200 g were taken in the