

Processing, new food application and development of improved bean cultivars

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Updated indications are provided for bean utilized for processing or extrusion process. The development of domestic varieties adapted to local conditions, with high yielding capacity and seed suitable for different uses, appears a prerequisite to increase the acreage of common bean. In Italy, breeding programmes carried out in the last years led to selection of advanced breeding lines and promising cultivars suitable to different kinds of utilization.

Keywords. *Phaseolus*, breeding, bean processing, new cultivars, seed uses, Italy.

Transformation, nouvelle utilisation alimentaire et création de nouveaux cultivars de haricots. Une mise-à-jour des utilisations industrielles du haricot pour la transformation et l'extraction de composants a été réalisée. La création de variétés améliorées adaptées aux conditions locales, avec une capacité de haut rendement et des graines appropriées pour de nombreux usages, apparaît comme une condition préalable pour augmenter la superficie cultivée en haricot. En Italie, les programmes d'amélioration menés durant ces dernières années ont abouti à la sélection de lignées avancées et de cultivars prometteurs appropriés aux nombreux usages potentiels du haricot en industrie alimentaire.

Mots-clés. *Phaseolus*, amélioration, transformation du haricot, création de cultivars, utilisation des graines, Italie.

1. INTRODUCTION

The common bean is traditional in Europe and is consumed as legume in its own right, as component of mixed vegetables or as a source for extrusion process. In ancient time the bean was exploited as dry seed (harvested at physiological maturity) or fresh seed (harvested from ripe pods and directly marketed). In this article, updated indications are provided for bean utilized for processing or extrusion process.

2. PROCESSING

The use of bean for freezing implies seed harvesting at a semi-dry stage (50–55% dry matter) with homogeneous maturity (i.e. 7 or 8 days before physiological maturity), the crop being harvested at one time. For canning process, seeds are harvested at semi-dry stage or at physiological maturity and dry seeds are submitted to a rapid rehydration to meet canning needs. Mechanical cultivation and industrial processing of the final product have directed efforts toward a bean ideotype including determinate growth habit, pods distributed on short upright vines, and uniform pod maturation, plant height, seed shape and size. High

seed weight (60–70 g/100 seeds) is required for freezing, while a high number of seeds per pod and high number of pods per plant contribute to improved plant yield potential despite determinate growth habit.

In the consumption of processed food, frozen beans occupy a prominent place. Blanching prior the freezing induces thermal inactivation of micro-organisms, preserving the quality and avoiding the nutrient degradation. The use of peroxidase or lipoxigenase as indicator enzymes for effective blanching has been proposed.

Frozen beans are submitted to sensory evaluation, and five sensory characteristics are evaluated: colour, flavour, texture, fibrousness and skin loss during boiling. An expert sensory panel including six or seven trained taste members perform this evaluation. This panel assigns a score to each characteristic evaluated according to a 5-point scale.

In cultivars for canning process, seed coat integrity and blanching treatment affect the quality of bean regeneration. Seed coat integrity has an influence on water uptake into dry bean. Damaged seed coats are usually lost when absorption of water and swelling cause the skins to separate from the slower hydrating cotyledons. After soaking, the cotyledons are separate

and processing equipment usually discards them. After a storage, the processed beans are evaluated for moisture drained weights, shear force, colour, subjective quality, and the brine for turbidity, this latter being dependent upon blanching treatment: water blanched beans usually exhibit less turbid brine than high temperature short time steam blanched beans.

3. FOOD APPLICATION

In recent years, the growing importance of edible beans and their fractions as a source for extrusion process to obtain new snack-type foods, has been reported (Aquilera *et al.*, 1984; Jeunink, Cheftel, 1979). Beans are high in protein, carbohydrates, fibre and mineral, making them a good source of nutrients. Results from previous researches on the extrusion of edible beans (Jeunink, Cheftel, 1979; Aquilera *et al.*, 1984; Gijksa and Khan, 1990; 1991) show satisfactory effect of extrusion for certain quality factors, especially for high starch fractions (HSF) or blends of bean proteins with cereals of low protein levels.

The high protein fraction of beans is pre-treated with papain and cellulases enzymes and extruded at a temperature of 120 °C. Enzymatic modifications have differential effects on nitrogen and carbohydrate components and on some physiological and functional properties of extrudates, depending on the type of enzyme and the incubation conditions. Results indicate the possibility of controlling protein and fibre hydrolysis at low moisture to obtain a desirable degree of modification to improve extruded products. This method may be used in food application to obtain new snack-type products from beans or their fractions (Czarnecki *et al.*, 1993).

4. DEVELOPMENT OF IMPROVED CULTIVARS (an Italian case study)

Varieties adapted to local conditions, with high yielding capacity and seeds suitable for different uses, are a prerequisite to increase the acreage of common bean. In Italy, two research groups belonging to the Istituto Sperimentale per l'Orticultura (Montanaso L.) and the Istituto Sperimentale per le Colture Industriali (Bologna) started breeding programmes in the late 70's (Allavena and Soressi, 1982; Allavena and Ranalli, 1988). The work is aimed at the development, through crossing, of a broad-based reservoir of beans with good diversity and adaptation; besides, another important target of the project is the finding of suitable selection criteria which can improve yield most efficiently. Finally, creation of improved varieties is the ultimate step of the breeding programmes.

4.1. Goals of the breeding programme

The main goal of the breeding programme is the development of varieties, well adapted to local conditions, and endowed with a high yielding capacity; besides, the characteristics of the seeds, suitable for freezing, canning and fresh market, are considered.

4.2. Plant ideotype

The plant ideotype that should be developed in the Italian conditions, should take into consideration several characteristics. The plant should bear numerous and close nodes, to facilitate light interception. The arrangement of phytomeric units should be such to facilitate a light interception throughout the canopy as uniform as possible. Besides, due to the high cost of the agro-technical practices, and because the short determinate growth habit is regarded as having the greatest potential for mechanized production, this trait should also be considered in the breeding programme.

Other important traits to be considered are pods distributed on short upright vines and with simultaneous ripeness; high seed weight, high number of seeds per pod and high number of pods per plant are characters that contribute to improve plant yield potential despite determinate growth habit.

BCMV (Bean Common Mosaic Virus) and halo blight are the most widespread and severe diseases affecting the crop in Italy; for this reason, every breeding programme in this country should involve the development of varieties resistant to these diseases.

Finally, the suitability of the seeds is evaluated by taking into account skin peeling, appearance, colour, firmness, and taste of the product after cooking.

4.3. Materials, breeding methods and criteria of selection

The main source of genetic variation, potentially useful for the introgression of the described traits, are accessions from gene banks or breeding lines already available. From this base material, suitable mating schemes are designed, to optimize the recombination and cumulation of valuable genes. On the basis of genealogical and SSD (Single Seed Descent) methods, segregant generations are obtained; it is advisable to perform one or two cycles of recurrent selection to promote the genetic recombination of valuable agronomic traits.

The outcome of the inter-crossing of superior genotypes can be identified on the basis of selection indexes; the evaluation of the breeding lines from the agronomic and market technology point of view is then performed.

Subsequently, yield testing of breeding lines is performed in comparative trials across different locations and cropping seasons; the last step is the release of the bred cultivars.

Among the selection criteria, highly heritable traits (Ranalli *et al.*, 1991) can be directly selected while components of seed yield (Ranalli, 1996; Campion *et al.*, 1998) are selected indirectly, on the basis of the following findings:

- the seed yield/plant is significantly correlated with pods/plant;
- the seed yield components have a simple genetic control and the environmental effects masking their phenotypic expression are reduced;
- the selection practiced simultaneously on the seed yield components positively affects the seed yield trait.

Another important selection criterion to be considered is the stability of performance, evaluated across different regions, and, as already pointed out above, the introgression of the resistance to BCMV and to halo blight, evaluated in the field as these diseases are naturally occurring, or/and in the greenhouse by inoculating the diseases mechanically through the leaves.

4.4. Results

The breeding efforts have developed different types of materials. Several promising cultivars were already submitted to the Italian National Register Bureau for approval, and released for large scale cultivation (borlotto type and cannellino type). Besides, advanced breeding lines are now being evaluated for the agronomic and technological performance; finally, it should be pointed out that as a side-product of this work, a wide germplasm including genes controlling valuable traits for many breeding purposes is available.

The suitability to different kinds of utilization is affected especially by the pod and seed characteristics. In this view, the developed cultivars can be ranked as follows:

- red striked pods and seeds: cultivars Delta and Talento;
- red striked pods and purpled striked seeds: cultivars Giulia, Granato, Minia and King;
- red striked pods and dark purpled striked seeds: cultivars Merit and Meraviglia;
- white pods and white seeds (cannellino type): cultivars Luxor and White Top.

5. PERSPECTIVES

The priorities in agriculturally and technologically well-developed countries have changed in recent years because of the problems caused by the overproduction

of some crops (i.e. cereals). This has drawn attention to the possibilities for increased cultivation of alternative crops, particularly locally adapted pulses. Also, the rediscovery of the Mediterranean diet in several countries among which Italy, is surely one of the factors contributing to increased daily consumption of common bean. The released cultivars of *Phaseolus vulgaris* provides two types of product: grains for direct freezing or canning, and dry seed when harvesting is made after the semi-dry stage. Dry seed is submitted to rapid rehydration to meet canning needs or utilized for extrusion of protein and starch fractions.

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