INFLUENCE OF ALIEN GENOME COMBINATIONS IN PROTEIN SYNTHESIS IN CEREALS

by

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ABSTRACT

Starch gel electrophoresis of the water-soluble, salt-soluble, acid-soluble and alcohol-soluble proteins of Triticale 6A190, Triticum durum, Secale cereale, Triticum vulgare and Tritipyron 6A58 revealed both qualitative and quantitative differences. The experimental evidence obtained indicated that the biosynthetic integrity of the alien genomes in the synthetic species(Triticale) was not fully maintained. The apparent variable influence of the tetraploid wheat (Triticum durum) genomes on protein synthesis in the three hexaploid cereals (Triticale 6A190, Triticum vulgare and Tritipyron 6A58) was observed.

TABLE OF CONTENTS

TABLE OF CONTENTS CONTINUED

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The first successful production of a synthetic cereal species, Triticale, was reported by Rimpau as early as 1888. Since then, intensive research has been carried out by cytologists and cytogeneticists with the aim of refining the development of these synthetic species both in the octaploid and the hexaploid levels. Biochemical effects presumably due to the presence of two alien genomes in these synthetic species had also been noted by some investigators in the past. Thus, Kowarski (1901) and Moritz (1933) both reported that serological similarities existed between the proteins found in the extracts of rye, wheat and the synthetic rye-wheat species (1,2). In recent years, some further research involving immunological techniques has been reported. Hall, in 1959, reported (3) results of immuno-electrophoresis studies of the octaploid Triticale and its parental species and implied that the integrity of the rye genomes was generally maintained in the species hybrid. More recently, Unrau and Vaisey (4), and Unrau and Jenkins (5) made a comparative survey of the milling, baking and some compositional characteristics between Triticale and their parental species and attributed some observed differences in these characteristics in the Triticale to the influence of the rye genome.

The investigations herein described and discussed were instigated in an attempt to establish whether an observable

change in the biosynthetic integrity of both the alien genomes present in the hexaploid synthetic species Triticale might occur. Since the hexaploid Triticale 6A190 is essentially derived through a combination of the genomes of Triticum durum and Secale cereale, both these parental species were included in the study. Furthermore, because Triticum vulgare (Kharkov) and Tritipyron 6A58 have the parental genomes, namely "AABB" of T. durum in common with Triticale 6A190, they were also included in the investigation.

REVIEW OF LITERATURE

As early as the late 18th century, attempts had been made to characterise the protein in wheat flour. A number of investigators such as Beccari (1745), Einhof (1805), Taddei (1820), de-Saussure, Berzelius, Boussingault, Liebig, Dumas and Ritthausen (1872) published reports on the isolation and characterisation of these wheat proteins. However, these early reports were confusing and somewhat contradictory due to a general lack of agreement in terminology and in the number of individual components believed to be present in the most thoroughly studied protein -- gluten (6,7). It can be stated that Osborne (1907) carried out the first comprehensive and systematic studies of wheat proteins. He characterised and identified the protein constituents of wheat flour on the basis of solubility in various solvents in conjunction with analytical analysis of the individual elements and amino acid composition of the protein fractions. In his investigations which were published in 1907, he stressed that gluten constitutes about 80 per cent of the total wheat flour protein and that gluten is an intimate mixture of two distinct individual proteins, glutenin and gliadin, and that both these were present in essentially equal amounts (7). With the introduction of ultracentrifuge and electrophoretic techniques in the 1930's, fairly convincing evidence became available indicating that gliadin

did not behave as a single molecular species (8,9,10). It must be pointed out that many of the electrophoretic studies carried out at that time, using the Tiselius electrophoresis apparatus, did not give symmetrical electrophoretic patterns (18). Even then, considerable work was conducted under these unfavourable conditions. Thus, in 1948, Laws and France reported that no significant differences could be detected in wheat gluten proteins derived from various sources (11). McCalla (1951) showed that electrophoresis of plant proteins in sodium salicylate solution was unsatisfactory (12). Kondo et al (1951) demonstrated by electrophoresis that gliadin and glutenin would only exist as a mono-component protein using an alkaline buffer (Kolthoff's buffer)(13,14). Lontie et al (1952) found that gluten consisted of three major and two minor components (15). Mills et al (1954) suggested that at least four protein components were present in gliadin (16). By using urea, Holme and Briggs (1959) succeeded in obtaining enantiographic patterns in moving boundary electrophoresis and found that three components were present in gliadin (17). In a search for a more suitable buffer system for wheat protein electrophoretic investigations, Jones et al (1959) discovered that aluminium lactate buffer was particularly effective (18). They showed that gluten contained at least four major and one minor component. One of the major components could be further resolved into two components when chloroacetate buffer

was used. Their findings were confirmed by Woychik et al (1960) who isolated these electrophoretic components by chromatographic fractionation and comparing their migration properties (19). Further investigations of Woychik et al (1961), using starch gel electrophoresis in the presence of urea, resolved gluten protein into nine components (20). At almost the same time, Elton in England also obtained similar results, by using the same technique (21) as that used by Woychik. Elton attributed the origin of the eight components that migrated into the gel to the gliadin fraction while the portion that remained at the origin corresponded to glutenin (22). Meanwhile, Zenter (1960) reported that seven components were detected in gluten by paper electrophoresis (23). Meredith et al (1960) re-examined gluten in the moving-boundary Tiselius apparatus and found that seven peaks were obtained, however, lack of symmetry in the patterns hindered interpretation of the results (24). Simmonds and Winzor (1961) separated the gluten proteins into eleven fractions by chromatography on carboxymethyl-cellulose columns (25). Graham (1963), using an improved apparatus and procedures for starch gel electrophoresis, showed that protein components having similar electrophoretic mobilities occurred in the extracts of wheat flour obtained when using a variety of solvents. However, there were marked differences in the proportions of these components in various

extracts (26). Pence and co-workers (1963) carried out electrophoresis of wheat proteins in poly-acrylamide gel. When electrophoresis was carried out in either phosphate or cacodylate buffer at pH 6, 15 to 17 protein components were apparently obtained for the acetic acid soluble fraction, whereas in aluminium lactate buffer, at pH 3.2, about 9 to 10 bands were observed. All the bands in the gel were accounted for in a fractionation involving the use of diethylamino-ethylcellulose ion-exchange resin (27). Lee and Wrigley (1963) investigated the gluten proteins of different wheat varieties and some tetraploid Triticum species by column chromatography on carboxymethyl-cellulose and by electrophoresis on polyacrylamide gel in basic buffer (28). Obvious differences in the electrophoretic patterns of the wheat varieties and the tetraploid species were observed. However, correlation of these patterns to baking quality could not be made because varieties having similar chromatographic and electrophoretic patterns were found to differ rather widely in baking quality. From results of moving boundary electrophoresis studies of some flour proteins, Kelly and Koenig (1963) suggested that wheats could be classified into groups according to their electrophoretic patterns (29). Wright et al (1964) demonstrated that gel-filtration could be applied to the study of cereal proteins together with starch gel electrophoresis (30). Most recently (1964) Elton and Ewart published re-