麵粉蛋白質組成對其麵糰物性與油炸麵筋球品質之影響

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摘 要

本研究以不同麥種之小麥進行碾磨並以取粉率為60％所取得之麵粉為原料，進行其一般組成分、FARINOGRAPH與EXTENSOGRAPH麵糰物性、油炸麵筋球品質及蛋白質組成分析，同時探討不同麵粉之蛋白質組成對其麵糰物性及油炸麵筋球品質之影響。 在麵粉基本組成與其麵糰物性之相關性分析方面，麵糰FARINOGRAPH物性值中之吸水量、離線時間及軟化指數與粗蛋白、濕筋及乾筋含量間呈顯著之正相關，而粗蛋白、濕筋及乾筋含量則與弱化度呈顯著之負相關。而麵糰EXTENSOGRAPH物性值中之延展性則與灰分含量呈顯著之正相關；黏彈性（抗展性）與水分含量呈正相關。 在油炸麵筋球品質與其麵糰物性之相關性方面，麵糰FARINOGRAPH物性值中之吸水量與油炸麵筋球之外觀品評分數呈正相關，而油炸麵筋球之尖峰力量、脆度、色澤B值與吸水量呈顯著之負相關；油炸麵筋球之色澤A值與離線時間、軟化指數呈負相關及油炸麵筋球品評之顏色深淺與弱化度亦呈負相關。在麵糰物性EXTENSOGRAPH方面，其延展性及抗展性與油炸麵筋球品質之間則無顯著相關性。 在麵粉之蛋白質組成與其麵糰物性之相關性方面，本研究依電泳分析之結果將麵粉蛋白質組成分成六個區分，其分子量分別為I：116.0 ~ 97.4、II：66.2、III：45.0、IV：36.0 ~ 24.0、V：24.0 ~ 19.7 及VI：19.7 ~ 6.5KDA。結果發現第I到V區分之蛋白質含量與FARINOGRAPH之吸水量呈顯著之正相關；第V與VI區分之蛋白質含量與離線時間亦呈顯著之正相關；第I、III 、V及VI區分之蛋白質含量與軟化指數呈顯著之正相關；而第IV及V區分之蛋白質含量與弱化度則呈顯著之負相關。另外，麥穀蛋白群（I + III）含量、醇溶蛋白群（II+ IV）含量及白蛋白、球蛋白群（V +VI）含量與吸水量及軟化指數亦呈顯著之正相關；與弱化度呈顯著之負相關。而在EXTENSOGRAPH物性值方面，則無明顯之相關性。 在麵粉之蛋白質組成與其油炸麵筋球品質之相關性方面，其結果為第I、II及V區分之蛋白質含量與油炸麵筋球之膨發體積、尖峰力量及HUNTER B值呈顯著之負相關；與HUNTER L、A值及外觀品評分數則呈顯著之正相關。另外，麥穀蛋白群（I + III）含量、醇溶蛋白群（II+ IV）含量及白蛋白、球蛋白群（V +VI）含量與尖峰力量、相對脆度、HUNTER A及B值呈顯著之負相關；與感官品評之外觀、顏色及整體接受性則呈顯著之正相關。 在不同溶劑抽取麵粉所得蛋白質之區分含量與其麵糰物性之相關性方面，以GLIADINS 、GLOBULINS及RESIDUES含量與FARINOGRAPH之吸水量呈顯著之正相關；而GLIADINS及RESIDUES含量與離線時間及軟化指數具有顯著之正相關；與弱化度皆呈負相關。而在EXTENSOGRAPH物性值方面，亦無明顯之相關性。 在不同溶劑抽取麵粉所得蛋白質之區分含量與其油炸麵筋球之相關性方面，GLIADINS及RESIDUES含量與油炸麵筋球之尖峰力量、相對脆度、HUNTER A及B值呈顯著之負相關；與感官品評之外觀、顏色及整體接受性分數則呈顯著之正相關。而GLOBULINS含量則與HUNTER A值呈顯著之正相關；與HUNTER B值呈顯著之負相關；與感官品評之外觀、顏色及整體接受性分數均呈顯著之正相關。 電泳分析結果顯示HMW GLUTENINS及Ω-GLIADINS的含量與麵糰FARINOGRAPH物性指標及油炸麵筋球品質間具有顯著之相關性；不同溶劑抽取蛋白質的分析結果顯示，GLIADINS含量與麵糰物性指標及油炸麵筋球品質之間亦具有顯著相關性，因此，可證實麵粉中之GLIADINS與GLUTENINS在麵粉之麵糰物性與其製品品質上確實扮演著重要的角色。

關鍵詞 : 麵筋、油炸麵筋球、蛋白質組成、蛋白質區分、麵糰物性、醇溶蛋白、麥穀蛋白

目錄

參考文獻

1.CNS。1979。總號 550，類號 N5007。總號 551，類號 N6002。 2.工業局。1990。麵製品業現況調查計畫成果報告。經濟部工業局及中華麵麥食品工業技術研究所。台北。 3.朱金鳳、張月櫻、徐華強。1992。專用麵粉及麵粉二次加工品質的研究。穀研所研究報告第二十四 輯。財團法人中華穀類食品工業技術研究所。台北。 4.李秀、賴滋漢。1990。食品分析與檢驗，P.153-155。精華出版社，台中。 5.吳景陽。1998。麵筋。食品工業30（7）:46-54。 6.徐華強、黃登訓、謝健一、顧德材。1974。實用麵包製作技術，PP.139-140，142-143。中華麵麥 食品工業研究所編印，台北。 7.張基郁、陳俊江、吳宗沛。1996。麵粉之麵糰ALVEOGRAPH特性與油炸麵筋球品質之相關性。中國農 化會誌34(3): 85-291。 8.郭文怡。1991。麵粉的分級及成分特性。烘焙工業35:45-51。 9.郭文怡。2001。以光譜儀快速檢測麵筋各組成蛋白質之分析方法。烘焙工業96:33-37。 10.陳俊江、張基郁。1994。麵粉化學成分與其物性指標之相關性研究。大葉學報3（1）:71-82。 11.陳志傑、吳宗沛、張基郁。1997。麵粉洗筋之食鹽水濃度與濕筋熟成時間對油炸麵筋球品質之影響 。食品科學24(1): 12-20。 12.陳勉之。1975。小麥蛋白質之組成及發酵麵食的製作功能。食品工業7（8）:15-18。 13.黃登訓。1988。硬質白麥。烘焙工業22:35-45。 14.黃謙勝、張為憲。1988。糙米擠壓條件及添加蛋白質對產品品質之影響。食品科學15(4):315-322。 15.鄔文盛、陳輝煌、鞏鳴盛、孫寶年。1989。米之雙軸擠壓加工-?。水分與油脂添加對米擠壓產品特性 之影響。食品科學16(4):305-318。 16.熊保榮。1995。麵粉蛋白質組成與油炸麵筋球品質之相關性研究。大葉工學院食品工程研究所碩士 論文。彰化。 17.鄭心嫻。1987。白米各類蛋白質之理化性質及其對米粉末糊化之影響。台灣大學食品科技研究所博 士論文。台北。 18.林苾芬。1999。麵粉蛋白質組成與其麵糰物性之相關性。大葉工學院食品工程研究所碩士論文。彰 化。 19.蔡清松。2000。談加入世界貿易組織國內大宗物資業者之走向。食品工業32（8）:49-56。 20.賴滋漢、金安兒。1991。食品加工學（製品篇），PP.14-18。精華出版社，台中。 21.賴喜美。1995。小麥與麵粉(上)。烘焙工業59:49-56。 22.賴喜美。1996。小麥與麵粉(下)。烘焙工業67:24-32。 23.楊鵑華。1993。麵包專用粉之特性與種類。烘焙工業47:54-57。 24.盧訓。1990。不同麵粉對麵皮理化特性之影響。J. CHIN. AGR. CHEM. SOC. 28(3): 219-236. 25.盧榮錦。1992。麵粉的品質與分析方法。美國小麥協會發行，台北。 26.AACC. AMERICAN ASSOCIATION OF CEREAL CHEMIST. 1995. APPROVED METHODS. AACC. ST. PAUL, MN. 27.BATEY, I. L., GUPTA, R. B. AND MACRITCHIE, F. 1991. USE OF SIZE-EXCLUSION HIGH-PERFORM -ANCE LIQUID CHROMATOGRAPHY IN THE STUDY OF WHEAT FLOUR PROTEINS: AN IMPROVED CHROMATO -GRAPHIC PROCEDURE. CEREAL CHEM. 68(2): 207-209. 28.BECKWITH, A. C. AND WALL, J. S. 1966. REDUCTION AND REOXIDATION OF WHEAT GLUTENIN. BIO -CHEM. BIOPHYS. ACTA 130: 155-159. 29.BELITZ, H. D. AND GROSCH, W. 1987. CHAPTER 15. CEREAL AND CEREAL PRODUCTS. FOOD CHEMIS -TRY. SPRINGER - VERLAG. 30.BETTGE, A., RUBENTHALER, G. L., AND POMERANZ, Y. 1989. ALVEOGRAPH ALGORITHMS TO PREDIC -T FUNCTIONAL PROPERTIES OF WHEAT IN BREAD AND COOKIE BAKING. CEREAL CHEM. 66(2): 81- 86. 31.BETTGE, A. D. AND CRAIG, F. M. 2000. RELATIONSHIPS AMONG GRAIN HARDNESS, PENTOSAN FRAC -TIONS, AND END-USE QUALITY OF WHEAT. CEREAL CHEM. 77(2): 241-247. 32.BIETZ, J. A. AND HUEBNER, F. R. 1980. STRUCTURE OF GLUTEN: ACHIEVEMENTS AT THE NORTHER -N REGIONAL RESEARCH CENTER. ANN. TECHNOL. AGRIC. 29: 249-253. 33.BIETZ, J. A. AND WALL, T. S. 1980. IDENTITY OF HIGH MOLECULAR WEIGHT GLIADIN AND ETHAN -OL-SOLUBLE GLUTENIN SUBUNITS OF WHEAT: RELATION TO GLUTEN STRUCTURE. CEREAL CHEM. 57 (6): 415-421. 34.BLOKSMA, A. H. AND BUSHUK W. 1988. RHEOLOGY AND CHEMISTRY OF DOUGH. IN "WHEAT CHEMISTR -Y AND TECHNOLOGY," ED. Y. POMERANZ, EDITOR.3RD ED. VOL II. ST. PAUL, MN. AM. ASSOC CEREAL CHEM. 131-217. 35.BOHLIN, L. AND GARLSON, T. L. 1980. DYNAMIC VISCOELASTIC PROPERTIES OF WHEAT FLOUR DOU -GH: DEPENDENCE ON MIXING TIME. CEREAL CHEM. 57(3): 174-177. 36.BRANLARD, G. AND DARDEVET, M. 1985. DIVERSITY OF GRAIN PROTEINS AND BREAD WHEAT QUALIT -Y. I. CORRELATION BETWEEN GLIADIN BANDS AND FLOUR QUALITY CHARACTERISTICS. J. CEREAL SCI. 3: 329-344. 37.BUSHUK, W. AND WRIGLEY, C. W. 1971. GLUTENIN IN DEVELOPING WHEAT GRAIN. CEREAL CHEM. 48(4): 448-455. 38.BUSHUK, W., KHAN, K. AND MCMASTER, G. 1980. FUNCTIONAL GLUTENIN: A COMPLEX OF COVALEN -TLY AND NON-COVALENTLY LINKED

COMPONENTS. ANNALES DE. TECHNOLOGIE AGRICOLE 29(2): 279 -294. 39.BUSHUK, W. AND MACRITCHIE, F. 1987. WHEAT PROTEIN: ASPECTS OF STRUCTURE THAT ARE RELA -TED TO BREAD-MAKING QUALITY. IN "PROTEIN QUALITY AND EFFECTS OF PROCESSING," ED. R. D. PHILLIPS, J. W. FINLEY, EDITORS. PP. 357-361. NEW YORK: MARCEL DEKKER. 40.CHANG, C. Y., SHYONG, P. R. AND CHANG, C. H. 1997. THE EFFECT OF SOLVENT ON THE EXTRAC TABILITY AND THE MOLECULAR SIZE DISTRIBUTION OF THE PROTEINS FROM WHEAT FLOUR. PROCEED -INGS OF THE NATIONAL SCIENCE COUNCIL, ROC, PART B: LIFE SCIENCES. 21(1): 26-30. 41.CHEFTEL, J. C., CUG, J. L. AND LORIENT, D. 1985. AMINO ACIDS, PEPTIDES, AND PROTEINS. IN "FOOD CHEMISTRY," ED. O. R. FENNEMA, , PP. 296-298. MARCEL DEKKER, INC., U.S.A. 42.CHEN, J., KHAN, K., SHELTON, D. R. AND D'APPOLONIA B. L. 1992. ISOLATION AND FRACTIONA -TION OF CARBOHYDRATE-CONTAINING PROTEINS FROM WHEAT GLUTEN. CEREAL CHEM. 69(5): 475- 480. 43.CHEN, J. J., SHYONG, P. R. AND CHANG C. Y. 1997. STUDIES ON THE ANALYTIC METHOD FOR THE QUALITY OF OIL-FRIED GLUTEN BALL. J. CHIN. AGR. CHEM. SOC. 35(1): 70-76. 44.CHEN, C. S., CHEN, J. J., WU, J. P. AND CHANG C. Y. 1998. OPTIMIZING THE FRY TEMPERAT -URE OF GLUTEN BALL USING RESPONSE SURFACE METHODOLOGY. J. SCI. FOOD & AGR. 77: 67-70. 45.CORBELLINI, M., EMPILLI, S., VACCINO, P., BRANDOLINI, A., BORGHI, B., HEUN, M. AND SAL -AMINI, F. 1999. EINKORN CHARACTERIZATION FOR BREAD AND COOKIE PRODUCTION IN RELATION TO PROTEIN SUBUNIT COMPOSITION. CEREAL CHEM. 76(5): 727-733. 46.CZUCHAJOWSKA, Z. AND POMERAMZ, Y. 1993. GAS FORMATION AND GAS RETENTION. I. ROLE OF VITAL GLUTEN DURING BAKING OF BREAD FROM LOW-PROTEIN OR FIBER-ENRICHED FLOUR. CEREAL FOODS WORLD. VOL. 38. NO. 7. PP. 504. 47.DANNO, G. 1981. EXTRACTION OF UNREDUCED GLUTENIN FROM WHEAT FLOUR WITH SODIUM DODECYL SULFATE. CEREAL CHEM. 58(4): 311-313. 48.DEXTER, J. E., PRESTON, K. R., TWEED, A. R., KILBORN, R. H. AND TIPPLES, K. H. 1985. RELATIONSHIP OF FLOUR STARCH DAMAGE AND FLOUR PROTEIN TO THE QUALITY OF BRAZILIAN-STY -LE HEARTH BREAD AND REMIX PAN BREAD PRODUCED FROM HARD RED SPRING WHEAT. CEREAL FOODS WORLD. 30(8): 511-514. 49.DEXTER, J. E., PRESTON, K. R., MARTIN, D. G. AND GANDER E. J. 1994. THE EFFECTS OF PRO -TEIN CONTENT AND STARCH DAMAGE ON THE PHYSICAL DOUGH PROPERTIES AND BREAD-MAKING QUAL -ITY OF CANADIAN DURUM WHEAT. J. CEREAL SCI. 20: 139-151. 50.DOEKES, G. J. AND WENNEKES, L. M. J. 1982. EFFECT OF NITROGEN FERTILIZATION ON QUANTI -TY AND COMPOSITION OF WHEAT FLOUR PROTEIN. CEREAL CHEM. 59(4): 276-278. 51.DONG, H., SEARES, R. G., COX, T. S., HOSENEY, R. C., LOOKHARTT, G. L. AND SHOGREN, M. D. 1992. RELATIONSHIPS BETWEEN PROTEIN COMPOSITION AND MIXOGRAPH AND LOAF CHARACTERIST -ICS IN WHEAT. CEREAL CHEM. 69(2): 132-136. 52.FINNEY, K. F. 1943. FRACTIONATING AND RECONSTITUTING TECHNIQUES AS TOOLS IN WHEAT FLO -UR RESEARCH. CEREAL CHEM. 20: 381-396. 53.FINNEY, K. F. AND BARMORE, M. A. 1948. LOAF VOLUME AND PROTEIN CONTENT OF HARD RED WIN -TER AND SPRING WHEATS. CEREAL CHEM. 25: 291. 54.FINNEY, K. F., HEYNE, E.G., SHOGREN, M.D., BOLTE, L.C. AND POMERANZ, Y. 1978. FUNCTION -AL PROPERTIES OF HIGH YIELDING EUROPEAN WHEATS GROWN AT MANHATTAN, KANSAS. CEREAL CHE -M. 30: 381-396. 55.GAINES, C. S. 1985. ASSOCIATIONS AMONG SOFT WHEAT FLOUR PARTICLE SIZE, PROTEIN CONTENT , CHLORINE RESPONSE, KERNEL HARDNESS, MILLING QUALITY, WHITE LAYER CAKE VOLUME, AND SU -GAR-SNAP COOKIE SPREAD. CEREAL CHEM. 62: 290-292. 56.GUPTA, R. B., AND MACRITCHIE, F. 1991. A RAPID ONE-STEP ONE-DIMENSIONAL SDS-PAGE PROC -EDURE FOR ANALYSIS OF SUBUNIT COMPOSITION OF GLUTENIN IN WHEAT. J. CEREAL SCI. 14: 105-109. 57.GUPTA, R. B., BATEY, I. L. AND MACRITCHIE, F. 1992. RELATIONSHIPS BETWEEN PROTEIN COM -POSITION AND FUNCTIONAL PROPERTIES OF WHEAT FLOURS. CEREAL CHEM. 69(2): 125-131. 58.HE, H. AND HOSENEY, R. C. 1991A. GAS RETENTION OF DIFFERENT CEREAL FLOURS. CEREAL CHEM . 68(4): 334-336. 59.HE, H. AND HOSENEY, R. C. 1991B. GAS RETENTION IN BREAD DOUGH DURING BAKING. CEREAL CHEM. 69(5): 521-525. 60.HE, H. AND HOSENEY, R. C. 1992. FACTORS CONTROLLING GAS RETENTION IN NONHEATED DOUGHS . CEREAL CHEM. 69(1): 1-6. 61.HOSENEY, R. C., FINNEY, K. F., SHOGREN, M. D. AND POMERANZ, Y. 1969A. FUNCTIONAL （BRE -ADMAKING） AND BIOCHEMICAL PROPERTIES OF WHEAT FLOUR COMPONENTS. II. ROLE OF WATER SOLUBLES. CEREAL CHEM. 46(2): 117-125. 62.HOSENEY, R. C., FINNEY, K. F., POMERANZ, Y. AND SHOGREN, M. D. 1969B. FUNCTIONAL （BRE -ADMAKING） AND BIOCHEMICAL PROPERTIES OF WHEAT FLOUR COMPONENTS. IV. GLUTEN PROTEIN -FRACTIONATION BY SOLUBILIZING IN 70% ETHYL ALCOHOL AND IN DILUTE LACTIC ACID. CEREAL CHEM. 46(5): 495-502. 63.HOSENEY, R. C. 1986. PRINCIPLE OF CEREAL SCIENCE AND TECHNOLOGY. 1ST ED. ST. PAUL, MN: AM. ASSOC. CEREAL CHEM. PP.3、327. 64.HOSENEY, R. C. AND FAUBION, J. M. 1989. THE VISCOELASTIC PROPERTIES OF WHEAT FLOUR DOU -GHS. IN "DOUGH RHEOLOGY & BAKED PRODUCT TEXTURE," ED. H. FARIDI AND J. M. FAUBION, PP. 29-66. VAN NOSTRAND REINHOLD, NEW YORK. 65.HOSENEY, R. C. 1990. PRINCIPLES OF CEREAL SCIENCE AND TECHNOLOGY. PP. 136-137. AMERIC -AN ASSOCIATION OF CEREAL CHEMISTS, INC. ST. PAUL, MN, USA. 66.HOSENEY, R. C. 1994. PRINCIPLE OF CEREAL SCIENCE AND TECHNOLOGY. PP. 378. AM. ASSOC. CEREAL CHEM. 1ST ED. ST. PAUL, MN. 67.HUEBNER, F. R. 1977. WHEAT FLOUR PROTEINS AND THEIR FUNCTIONALITY IN BAKING. BAKER'S DIG. 51(5): 25, 154. 68.HUANG, Y. C., LIN Z. Y., LUR H. S., AND CHU C. 1994. VARIETY IDENTIFICATION AND QUALI -TY CHARACTERIZATION OF MILLED RICE GRAINS USING REVERSE-PHASE HIGH PERFORMANCE LIQUID CHROMATOGRAPHY.TECHNIQUE

DEVELOPMENT, PROLAMINES, GLUTELINS AND VARIETY CHARACTERIZATI -ON. J. CHIN. AGR. CHEM. SOC. 171:1-13. 69.HUANG, D. Y. AND KHAN, K., 1997A. QUANTITATIVE DETERMINATION OF HIGH MOLECULAR WEIGHT GLUTENIN SUBUNITS OF HARD RED SPRING WHEAT BY SDS-PAGE. I. QUANTITATIVE EFFECTS OF TOT -AL AMOUNTS ON BREADMAKING QUALITY CHARACTERISTICS. CEREAL CHEM. 74(6): 781-785. 70.HUANG, D. Y. AND KHAN, K., 1997B. QUANTITATIVE DETERMINATION OF HIGH MOLECULAR WEIGHT GLUTENIN SUBUNITS OF HARD RED SPRING WHEAT BY SDS-PAGE. II. QUANTITATIVE EFFECTS OF INDIVIDUAL SUBUNITS ON BREADMAKING QUALITY CHARACTERISTICS. CEREAL CHEM. 74(6): 786-790. 71.HUSSAIN, A. AND LUKOW, O. M., 1997. INFLUENCE OF GLIADIN-RICH SUBFRACTIONS OF GLENLEA WHEAT ON THE MIXING CHARACTERISTICS OF WHEAT FLOUR. CEREAL CHEM. 74(6):791-799. 72.INOUE, Y. AND BUSHUK, W. 1992. STUDIES ON FROZEN DOUGHS. II. FLOUR QUALITY REQUIREMEN -TS FOR BREAD PRODUCTION FROM FROZEN DOUGHS. CEREAL CHEM. 69(4): 423-428. 73.INOUE, Y., SAPIRSTEIN, H. D., TAKAYANAGI, S. AND BUSHUK, W. 1994. STUDIES ON DOUGHS. III. SOME FACTORS INVOLVED IN DOUGH WEAKENING DURING FROZEN STORAGE AND THAW-FREEZE CYCLES. CEREAL CHEM. 71(2): 118-121. 74.JOHNSON, J. M., GRIFFEY, C. A. AND HARRIS, C. H. 1999. COMPARATIVE EFFECTS OF 1BL/1RS TRANSLOCATION IN RELATION TO PROTEIN COMPOSITION AND MILLING AND BAKING QUALITY OF SOF -T RED WINTER WHEAT. CEREAL CHEM. 76(4): 467-472. 75.KASARDA, D. D., NIMMO, C. C. AND KOHLER, G. O. 1971. PROTEINS AND THE AMINO ACID COMP -OSITION OF WHEAT FRACTIONS. IN "WHEAT: CHEMISTRY AND TECHNOLOGY," ED. Y. POMERANZ. PP . 227-299. 2ND ED. ST. PAUL, MN. AM. ASSOC. CEREAL CHEM. 76.KASARDA, D. D., BERNARDIN, J. E. AND NIMMO, C. C. 1976. WHEAT PROTEINS. ADV. CEREAL SCI. & TECHNOL. 1: 158-236. 77.KASARDA, D. D., WOODARD, K. M. AND ADALSTEINS, A. E. 1998. RESOLUTION OF HIGH MOLECUL -AR WEIGHT GLUTENIN SUBUNITS BY A NEW SDS-PAGE SYSTEM INCORPORATING A NEUTRAL PH BUFF -ER. CEREAL CHEM. 75(1): 70-71. 78.KHAN, K., TAMMINGA, G. AND LUKOW, O., 1989. THE EFFECT OF WHEAT FLOUR PROTEINS ON MIXI -NG AND BAKING CORRELATIONS WITH PROTEIN FRACTIONS AND HIGH MOLECULAR WEIGHT GLUTENIN SUBUNIT COMPOSITION BY GEL ELECTROPHORESIS. CEREAL CHEM. 66(4): 391-396. 79.KIM, J. -J. KIEFFER, R. AND BELITZ, H. -D. 1988. RHEOLOGICAL PROPERTIES OF WHEAT GLUT -EN, CONTAINING DIFFERENT AMOUNTS OF PROLAMINS FROM VARIOUS CEREALS. Z. LEBENSM. UNTER S. FORSCH. 186: 16-21. 80.KULP, K. 1995. BIOCHEMICAL AND BIOPHYSICAL PRINCIPLES OF FREEZING. IN "FROZEN AND REFR IGERATED DOUGHS AND BATTERS," ED. K. KULP, K. LORENZ, AND J. BRUMMER, EDITORS. PP. 63- 89. 1ST ED. ST. PAUL, MN. AM. ASSOC. CEREAL CHEM. 81.L'ASZTITY, R., NEDELKOVITS, J. AND VARGA, J. 1970. THE STRUCTURE OF THE HIGH MOLECULAR WEIGHT PROTEIN COMPONENT OF GLUTEN. PAPER PRESENTED AT THE IUPAC SYMPOSIUM, RIGA. 82.L'ASZTITY, R. 1972. RECENT RESULTS IN CEREAL PROTEIN RESEARCH. PERIOD. POLYTECH. (TECH . UNIV. BUDAPEST) 16: 331-335. 83.LARROQUE, O., GIANIBELLI, M. C. AND MACRITCHIE, F. 1999, PROTEIN COMPOSITION FOR PAIRS OF WHEAT LINES WITH CONTRASTING DOUGH EXTENSIBILITY. J. CEREAL SCI. 29 : 27-31. 84.LAWRENCE, G. J., 1986. THE HIGH-MOLECULAR-WEIGHT GLUTENIN SUBUNIT COMPOSITION OF AUSTR -ALIAN WHEAT CULTIVARS. AUST. J. AGRIC. RES. 37: 125-133. 85.LAWRENCE, G. J., MOSS, H. J., SHEPHERD, K. W. AND WRIGLEY, C. W. 1987. DOUGH QUALITY OF BIOTYPES OF ELEVEN AUSTRALIAN WHEAT CULTIVARS THAT DIFFER IN HIGH MOLECULAR WEIGHT GLUTENIN SUBUNIT COMPOSITION. J. CEREAL SCI. 6: 99-101. 86.LAWRENCE, G. J., MACRITCHIE, F. AND WRIGLEY, C. W. 1988. DOUGH AND BAKING QUALITY OF WHEAT LINES DEFICIENT IN GLUTENIN SUBUNIT CONTROLLED BY GLU-A1, GLU-B1 AND GLU-D1 LOCI . J. CEREAL SCI. 7: 109-112. 87.LEE, J. W. AND MACRITCHIE, F. 1971. THE EFFECT OF GLUTEN PROTEIN FRACTIONS ON DOUGH PR OPERTIES. CEREAL CHEM. 48(6): 620-625. 88.LOWRY, O. H., ROSEBROUGH, J., FARR, A. L. AND RANDALL, J. 1951. J. BIOL. CHEM. 193: 265. 89.MACRITCHIE, F. 1978. DIFFERENCES IN BAKING QUALITY BETWEEN WHEAT FLOURS. J. FOOD TECHN -OL. 13: 187-194. 90.MACRITCHIE, F. 1980A. PHYSICOCHEMICAL ASPECTS OF SOME PROBLEMS IN WHEAT RESEARCH. ADV. CEREAL SCI. TECHNOL. 3: 271-321. 91.MACRITCHIE, F. 1980B. STUDIES OF GLUTEN PROTEIN FROM WHEAT FLOURS. CEREAL FOODS WORLD. 25(7): 382-385. 92.MACRITCHIE, F. 1984. BAKING QUALITY OF WHEAT FLOURS. ADV. FOOD RES. 29: 201-277. 93.MACRITCHIE, F. 1985. STUDIES OF THE METHODOLOGY FOR FRACTIONATION AND RECONSTITUTION OF WHEAT FLOUR. J. CEREAL SCI. 3: 221-230. 94.MACRITCHIE, F. 1987. EVALUATION OF CONTRIBUTIONS FROM WHEAT PROTEIN FRACTIONS TO DOUGH MIXING AND BREAD MAKING. J. CEREAL SCI. 6: 259-268. 95.MACRITCHIE, F., DU CROS, D. L. AND WRIGLEY, C.W. 1990. FLOUR POLYPEPTIDES RELATED TO WHEAT QUALITY. IN "ADVANCES IN CEREAL SCIENCE AND TECHNOLOGY," ED. Y. POMERANZ, VOL. 10. PP. 79-145. ST. PAUL, MN. AM. ASSOC. CEREAL CHEM.. 96.MASI, P., CAVELLA, S. AND SEPE, M. 1998. CHARACTERIZATION OF DYNAMIC VISCO-ELASTIC BEH -AVIOR OF WHEAT FLOUR DOUGHS AT DIFFERENT MOISTURE CONTENTS. CEREAL CHEM. 75(4): 428- 432. 97.MCCANE, R. A. 1945. THE CHEMICAL COMPOSITION OF WHEAT AND RYE AND OF FLOURS DERIVED THEREFROM. BIOCHEM. J. 39: 213-216. 98.MEREDITH, O. B. AND WREN, J. J. 1966. DETERMINATION OF MOLECULAR-WEIGHT DISTRIBUTION IN WHEAT FLOUR PROTEINS BY EXTRACTION AND GEL FILTRATION IN A DISTRIBUTION MEDIUM. CER -EAL CHEM. 43: 169-186. 99.MIKHAYLENKO, G. G., CZUCHAJOWSKA, Z., BAIK, B. -K. AND KIDWELL, K. K. 2000. ENVIRONME -NTAL INFLUENCES ON FLOUR COMPOSITION, DOUGH RHEOLOGY,

AND BAKING QUALITY OF SPRING WHEAT. CEREAL CHEM. 77(4): 507-511. 100.MIMOUNI, B., ROBIN, J. M., AZANZA, J. -L. AND RAYMOND, J. 1998. WHEAT FLOUR PROTEINS: ISOLATION AND FUNCTIONALITY OF GLIADIN AND HMW-GLUTENIN ENRICHED FRACTIONS. J. SCI. FO -OD AGRIC. 78: 423-428. 101.ODA, M., YASUDA, Y., OKAZAKI, S., YAMAUCHI, Y. AND YOKOYAMA, Y. 1980. A METHOD OF FLO -UR QUALITY ASSESSMENT FOR JAPANESE NOODLES. CEREAL CHEM. 57(4):253-254. 102.OH, N. H., SEIB, P. A., DEYOE C. W. AND WARD, A. B. 1983. NOODLE. I. MEASURING THE TEX -TURAL CHARACTERISTICS OF COOKED NOODLES. CEREAL CHEM 60(6): 433-438. 103.OH, N. H., SEIB, P. A., DEYOE C. W. AND WARD, A. B.1985A. NOODLES II:THE SURFACE FIRM -NESS OF COOKED NOODLES FROM SOFT AND HARD WHEAT FLOUR. CEREAL CHEM. 62(6): 431-436. 104.OH, N. H., SEIB, P. A., DEYOE C. W. AND WARD, A. B.1985B. NOODLES IV:FLOUR PROTEIN, EXTRACTION RATE, PARTICLE SIZE AND STARCH DAMAGE ON THE QUALITY CHARACTERISTICS IN DRY NOODLES. CEREAL CHEM. 62(6): 441-446. 105.ORTH, R. A., BAKR, R. J. AND BUSHUK, W. 1972. STATISTICAL EVALUATION OF TECHNIQUES FOR PREDICTING BAKING QUALITY OF WHEAT CULTIVARS. CAN. J. PLANT SCI. 52: 139-143. 106.ORTH, R. A. AND BUSHUK, W. 1973. STUDIES OF GLUTENIN. II. RELATION OF VARIETY, LOCATIO -N OF GROWTH AND BAKING QUALITY TO MOLECULAR WEIGHT DISTRIBUTION OF SUBUNITS. CEREAL CHEM. 50(2): 191-197. 107.OSBORNE, T. B. 1907. THE PROTEINS OF THE WHEAT KERNEL. PUBL. 84. CARNEGIE INSTITUTE OF WASHINGTON: WASHINGTON, D.C. 108.PASARIBU, S. J., TOMLINSON, J. D. AND MCMASTER, G. J. 1992. FRACTIONATION OF WHEAT FLO -UR BY SIZE EXCLUSION-HPLC ON AN AGAROSE-BASED MATRIX. J. CEREAL SCI. 15: 121-136. 109.PAYNE, P. I. AND LAWRENCE, G. J. 1983. CATALOGUE OF ALLELES FOR THE COMPLEX GENE LOCI, GLU-A1, GLU-B1 AND GLU-D1 WHICH CODE FOR HIGH MOLECULAR WEIGHT SUBUNITS OF GLUTENIN IN HEXAPLOID WHEAT. CEREAL RES. COMMUN 11:29-35. 110.PAYNE, P. I., NIGHTINGALE, M. A., KRATTIGER, A. F. AND HOLT, L. M. 1987. THE RELATIONS -HIP BETWEEN HMW GLUTENIN SUBUNIT COMPOSITION AND THE BREAD- MAKING QUALITY OF BRITISH -GROWN WHEAT VARIETIES. J. SCI. FOOD AGRIC. 40: 51-65. 111.PELTONEN, J. AND VIRTANEN, A. 1994. EFFECT OF NITROGEN FERTILIZERS DIFFERING IN RELEAS -E CHARACTERISTICS ON THE QUANTITY OF STORAGE PROTEIN IN WHEAT. CEREAL CHEM. 71(1): 1- 5. 112.PENCE, J. W. AND OLCOTT, H. S. 1952. EFFECT OF REDUCING AGENTS ON GLUTEN PROTEIN. CERE -AL CHEM. 29: 292-296. 113.POMERANZ, Y. 1987. MODERN CEREAL SCIENCE AND TECHNOLOGY, VCH PUBLISHERS, INC, U.S.A., PP. 26-29. 114.POMERANZ, Y. 1988. WHEAT: CHEMISTRY AND TECHNOLOGY VOLUME II. PP. 11. AMERICAN ASSOCIA -TION OF CEREAL CHEMISTS, INC. ST. PAUL, MN, U.S.A. 115.PRESTON, K. R. AND HOSENEY R. C. 1991. APPLICATIONS OF THE EXTENSIGRAPH. IN: RASPER, V. F., PRESTON, K. R., EDITORS. THE EXTENSOGRAPH HANDBOOK. ST. PAUL, MN: AM. ASSOC. CEREAL CHEM.13-19. 116.PRESTON, K. R., LUKOW, O. M. AND MORGAN, B. 1992. ANALYSIS OF RELATIONSHIPS BETWEEN FLOUR QUALITY PROPERTIES AND PROTEIN FRACTIONS IN A WORLD WHEAT COLLECTION. CEREAL CHE -M. 69(5): 560-567. 117.SAS INSTITUTE, INC. 1985. SAS USER'S GUIDE: STATISTICS VERSION 5TH ED. SAS INST. CARY, NC., U.S.A. 118.SAFARI-ARDI, M. AND PHAN-THIEN, N. 1998. STRESS RELAXATION AND OSCILLATORY TESTS TO DI -STINGUISH BETWEEN DOUGHS PREPARED FROM WHEAT FLOURS OF DIFFERENT VARIETAL ORIGIN. CER -EAL CHEM. 75(1): 80-84. 119.SCHOFIELD, R. K. AND SCOTT-BLAIR G. W. 1932. THE RELATIONSHIP BETWEEN VISCOSITY, ELAST -ICITY AND PLASTIC STRENGTH OF SOFT MATERIALS AS ILLUSTRATED BY SOME MECHANICAL PROPER -TIES OF FLOUR DOUGHS. I. LONDON: PROC. ROY. SOC. A138: 707-718. 120.SCHROPP, P. AND WIESER, H. 1996. EFFECTS OF HIGH MOLECULAR WEIGHT SUBUNITS OF GLUTENIN ON THE RHEOLOGICAL PROPERTIES OF WHEAT GLUTEN. CEREAL CHEM. 73(3): 410-413. 121.SHEWRY, P. R., TATHAM, A. R., FORDE, J., KREIS, M. AND MIIFLIN, B. J. 1986. THE CLASSI -FICATION AND NOMENCLATURE OF WHEAT GLUTEN PROTEIN: A REASSESSMENT. J. CEREAL SCI. 4: 97-106. 122.SHEWRY, P. R., HALFORD, N. G. AND TATHAM, A. S. 1992. HIGH MOLECULAR WEIGHT SUBUNITS OF WHEAT GLUTENIN. J. CEREAL SCI. 15: 105-120. 123.SINGH, N. K., DONOVAN, G. R., BATEY, I. L. AND MACRITCHIE, F. 1990A. USE OF SONICATION AND SIZE-EXCLUSION HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY IN THE STUDY OF WHEAT FLOUR PROTEINS. I. DISSOLUTION OF TOTAL PROTEINS IN THE ABSENCE OF REDUCING AGENTS. CEREAL CHEM. 67(2): 150-161. 124.SINGH, N. K., DONOVAN, G. R. AND MACRITCHIE, F. 1990B. USE OF SONICATION AND SIZE-EXCL -USION HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY IN THE STUDY OF WHEAT FLOUR PROTEINS II. RELATIVE QUANTITY OF GLUTENIN AS A MEASURE OF BREADMAKING QUALITY. CEREAL CHEM. 67(2): 161-170. 125.SINGH, N. K., SHEPHERD, K. W. AND CORNISH, G. B. 1991. A SIMPLIFIED SDS-PAGE PROCEDURE FOR SEPERATING LMW SUBUNITS OF GLUTENIN. J. CEREAL SCI. 14: 203-208. 126.SOUZA, E., KRUK, M. AND SUNDERMAN, D. W. 1994. ASSOCIATION OF SUGAR-SNAP COOKIE QUALI -TY WITH HIGH MOLECULAR WEIGHT GLUTENIN ALLELES IN SOFT WHITE SPRING WHEATS. CEREAL CHEM. 71: 601-605. 127.STEVENS, H. H. 1992. CONTROL OF PRODUCT QUALITY IN THE MILL. 麵粉場之良好作業規範研討 會專輯。中華麵麥食品工業技術研究所編印，台北。 128.SWANSON, C. O. 1938. WHEAT AND FLOUR QUALITY. BURGESS PUBLISHING CO., MINNEAPOLIS, MN. 129.TATHAM, A. S. AND SHEWRY, P. R. 1985. THE CONFORMATION OF WHEAT GLUTEN PROTEINS. THE SECOND STRUCTURE AND THERMAL STABILITIES OF a-, b-, AND g-GLIADINS. J. CEREAL SCI. 3: 103-113. 130.TIPPLES, K. H., MEREDITH, J. O. AND HOLAS, J. 1978. FACTORS AFFECTING FARINOGRAPH AND BAKING ABSORPTION. II.

RELATIVE INFLUENCE OF FLOUR COMPONENTS. CEREAL CHEM. 55(5): 652 -660. 131.UTHAYAKUMARAN, S., NEWBERRY, M., KEENTOK, M., STODDARD, F. L. AND BEKES, F. 2000. BAS -IC RHEOLOGY OF BREAD DOUGH WITH MODIFIED PROTEIN CONTENT AND GLUTENIN-TO-GLIADIN RAT -IOS. CEREAL CHEM. 77(6):744-749. 132.WALL, J. S. 1979. THE ROLE OF WHEAT PROTEINS IN DETERMINING BAKING QUALITY. IN `RECE -NT ADVANCES IN THE BIOCHEMISTRY OF CEREALS´ EDS, D. L. LAIDMAN AND R. G. W. JONSE, ACADEMIC PRESS, NEW YORK. 133.WEEGEL, P. L., HAMER, R. J. AND SCHOFIELD, J. D. 1996. FUNCTIONAL PROPERTIES OF WHEAT GLUTENIN (CRITICAL REVIEW). J. CEREAL SCI. 23: 1-18. 134.WIESER, H., ANTES, S. AND SEILMEIER, W. 1998. OUANTITATIVE DETERMINATION OF GLUTEN PRO -TEIN TYPES IN WHEAT FLOUR BY REVERSED-PHASE. HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY. CEREAL CHEM. 75(5): 644-650. 135.WIESER, H. 2000. SIMPLE DETERMINATION OF GLUTEN PROTEIN TYPES IN WHEAT FLOUR BY TURBID -IMETRY. CEREAL CHEM. 77(1): 48-52. 136.WRIGLEY, C. W. AND BIETZ, J. A. 1988. PROTEINS AND AMINO ACIDS. IN `WHEAT CHEMISTRY AND TECHNOLOGY´ BY POMERANZ Y, EDITORS. 3RD ED. VOL. I. ST. PAUL, MN: AM. ASSOC. CEREAL CHEM. 159-275. 137.YAMAZAKI, W. T. 1959. FLOUR GRANULARITY AND COOKIE QUALITY. II. EFFECT OF WHEAT VARIET -Y ON SIEVE FRACTION PROPERTIES. CEREAL CHEM. 36: 42-51.