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# Evolution and genetic diversity of the wheat species of *T. turanicum* Jakubz. and their selection value

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**Abstract:** It has been comparatively studied the forms of *Turan* type of wheat with different ecological origins and turanoid forms formed as a result of hybridization and gathered into gene pool from Azerbaijan area, *Devedishi*, the ancient people selection species of Azerbaijan, which is related to the type of *T. turanicum* Jakubz., *Turanicum-186* gained by I.D. Mustafayev based on electrophoreogram of gliadine fraction of protein. The *Devedishi* in Azerbaijan and the selection of popular species *Turatish* in other Turkic states has been proved to be of the same origin. The *Turan* wheat is a donor for the formation of big grained, high-quality wheat. This species has been proven to be one of the parental forms in the evolution of the *Secale L.*

**Keywords:** Gliadin, Electrophoresis, *T. Turanicum* Jakubz., *Turanicum-186*, Evolution

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## 1. Introduction

The synonymous names of the *T. turanicum* Jakubz. species: *T. orientale* Perc. (Eastern wheat), *T. percivalli* Hubbard. ex. Schiem. - Persival wheat, *T. mesopotomicum* Jakubz. - Mesopotomian wheat [1, 2, 3, 4]. The Azerbaijan popular selection species of this wheat is called *Devedishi*. Some researchers taking into account that this wheat was found in the tombs of the Egyptian pharaohs in ancient times, called it as the "King Tut's Wheat", Tutankhamen wheat [5,6], other authors which based on the religious books, taking into account the use of it in the ship of Noah called it as the "grain of Prophet" [7]. According to many sources the wheat was imported to Egypt from another country, and in that country it was called as the "Camel's tooth" - "Devedishi". Ancient Turks called camel as "tur, deve, tooth- dishi". As the wheat grain is big and elongated, Uzbeks, Turkmen and Kazakhs called it as "Turatish", but the Azeri Turks as "Devedishi". Armenians based on the remnants of the *Turan* wheat found during the archaeological excavations in the Azerbaijani areas remained in the territory of the Republic of Armenia are trying to prove the "Devedishi" species to be the popular selection and thus to prove them to be a state with the ancient civilization [4, 7]. In this regard, a group of Armenian scientists tried to change the name of *T. turanicum* Jakubz. type (wheat called by the name of the area of distribution of

the Turks), adopted in the international botanical classification, with synonymous names such as *T. orientale* Perc., *T. percivalli* Hubbard. ex. Schiem., and the name of species variety which is in "dead Latin language" with the words of Armenian origin. For example: Gandilian P.A. by replacing *T. turanicum* var. *gazimustafakemal* Geokg. species types, *arnual(al)*, var. *turanoprovinciale* Must.- *arnuruni(al)*, var. *turanoapulicum* Must.- *narpuru(ru)*, var. *bandrmanicum* Hacizade. - *arpual(ru)* etc. [4] falsifies the science. *T. turanicum* Jakubz. was for the first time recorded as a separate species by N.K. Vasilyev in 1899. It was included to the system as the species variety by P.P. Shreder (1913), and as a new species - *T. orientale* Perc. (Eastern wheat) by J. Persival (1921) [3]. The type of wheat is grown in Azerbaijan, Iran, China, Turkey, Turkmenistan, Uzbekistan and Tajikistan. *Turan* wheat was grown in the territories where Turkish nations are spread, beginning from the ancient times until recently, and is noted as buckwheat in the international statistical information. Due to the weak bush, the productivity of the species existing till 1930-33 years was 1.5-3.5 ton per hectare in Azerbaijan and Turkey under cultivation conditions [6].

*Turan* wheat was grown and planted in Azerbaijan in a wide range until the period of the collectivization (1932-

1936). In subsequent periods after the establishment of productive varieties of wheat in Azerbaijan, they are found as mixed type in the wheat plantations. I.D. Mustafayev found 12 species varieties of Turan wheat in the plantations in Azerbaijan and only 5 of them were included to the botanical literature for the first time: *var. turanoaffine* Must., *var. turano-alexandrinum* Must., *var. turanoleucurum* Must., *var. turanoniqrum* Must., *var. turano-apulicum* Must. [2,3].

## 2. Material and Methods

As an object of study, Turanicum-186 and large grain type given from the gene pool of grains of Garabagh SRB in 1980 (both sorts included to the *var. insigne* species variety), *var. turanoaffine* Must., *var. turano-alexandrinum* Must., *var. turanoleucurum* Must., *var. turanoniqrum* Must., *var. turano-apulicum* Must.; *T.dicocum var. farrum*, *T.dicocum var. rufum*, Zogal buqda (Cranberry wheat), Turan wheat KT-0012 from Iran, Turanicum-kT-0014 from China, (Iran, Urmia Field Crops Research Center), Turatish kT-0015 (Uzbekistan) brought by the author from Van, Turkey in 1994, kT-0016 (Turkey) and the hybrid forms gained as a result of hybridization in 1980-2003 were used. The study was held under 550V voltages during 2.5 hours in electrophoresis Polyacrylamide gel of gliadine proteins with pH 3.1 aluminum lactate.

## 3. Experimental

As a result of years of experience it was found out that Turan wheat is warmer climate crop due to the environmental characteristics. It gives good crop yields in the irrigated areas. It is possible to sow Turan wheat in the spring and autumn. According to the environmental feature, it is very close to the buckwheat. According to the ripening period, it has fast (*KT-0015*, Uzbekistan) and ultra-fast growing (*KT-0014*, China) forms.

Turan wheat was used by us in hybridization of species and type. Comparison with other wheat hybrids shows that they are good donor for short, large spikes types. Hydrides of this wheat with soft wheat may form *duroid*, *percicoide*, *speltoid* and *compactoid* wheat.

The negative nature is that it sometimes may be infected with black-and-purple germ disease. But it does not lower its quality. Our observations confirm that the existence of this sign in separate grains due to the air humidity is a result of increase of anthocyanins in its genotype. When the grains with such embryo start to spring, the stems of the plants are in purple-green color; however, their grains do not have this sign.

The weight of 1000 grains of Turan wheat is 54-65g and more, and this makes it the world's largest cereal wheat. The grains of Turan wheat are humpbacked, sickle-like, and elongated. It is 100% glassy, dark and light amber color. We defined that there is 26,1 - 14,6% of the protein in the content of grains of *turanoide* wheat, formed as a result of distant genetic hybridization, and *T.turanicum* Jakubz. collected

from different areas to the genetic fund. The amount of irreplaceable amino acid lysine in the composition of grain protein is 2.09 - 2.78%. Its yield is higher as the grains are large and glassy.

The grain of Turan wheat growing in the territory of Nakhchivan Autonomous Republic is glassy, and from its flour it is prepared high-quality macaroni, oven bread in various shapes, lavash of excellent quality, noodles, confectionery, candy, halva, porridge and roasted wheat etc. Noodles and cereals have special taste. Various breads made from its flour became stale later, lavash breads are highly appreciated for its special fragrance and color.

Negative features: it is not durable to drought and cold, insects and helminthiasis diseases. As its spike and grains are large, it is bent down, and due to this feature, it is called "Stork wheat" by some Turkic peoples (Moldova), it is also inclined to lie down. In humid weather, the leaves of Turan wheat are not durable to the yellow rust and stibium disease.

Large grained wheat which is the Azerbaijan's national selection is widely used as productive, high-protein hybrid forms are gained while hybridizing them with variety of other types of wheat. It is easily hybridized with A<sup>u</sup>B, A<sup>u</sup>BD genetic wheat [8].

The hybride F<sub>1</sub> of Turan wheat with *T. boeoticum* Boiss. and *T. monococcum* L. is sterile. It is easily hybridized with *T. turanicum*, *T. compactum*, *T. macha* and forms highly fertile lines [9].

It is formed 60-85% from hybrids of Turan wheat as *T.durum*, *T. dicocum*, *T. aestivum* and from *T. pericum*, *T. aethiopicum* wheat as straight and reciprocal, and germination percentage of grains is high. Its hybrids with hexaploid wheat form different types and species by forking in wide range in F<sub>2</sub> generation.

*T. turanicum* x *T. petropavlovskiyi* hybrid population forms *T. petropavlovskiyi*, *T. polonicum*, *T. durum*, *T. turanicum* types and intermediate forms in F<sub>2</sub> generation. In F<sub>2</sub> hybrid of *T. turanicum* x *T. aestivum* and *T. compactum* forms variety of hard wheat species- *turanoid*, *speltoid*, *compactoid*, *duroid*, *dicocoid* (18 - 22cm in length) ears, easy and hard to thresh.

Potokina S.A (1967) having studied the signs of economic value of *T. turanicum* came to the conclusion that this type of wheat is monotype, has a small, natural habitat, ecologically less plastic, with less interspecific differences. However, it is resistant to drought and heat. *T. turanicum* type is divided into 2 ecological groups: Iran-Turkey and the Caucasus-Anatolian groups. The Iran-Turkey ecotype forms are moderately drought-resistant, but the Caucasus - Anatolian group are moister-loving plants. Potokina S.A. notes that Turan wheat does not hybridize with *T. militinae*, *T. montanum*, *T. timopheevii*, *T. zhukovskiyi* wheats [10].

According to our results, there are no any fundamental differences among these ecotypes. They have got divergent in terms of sowing as a result of hybridization with other wheats. Plants of both ecotypes during the hybridization with hard wheats in the conditions of Nakhchivan Autonomous Republic is generated large spikes, glassy grains, productive forms (F<sub>3</sub>). The weight of 100 grains of Turanicum - 186

hybrids of different species reaches to 70 – 80gr. In hybrids of Turanikum with a variety of different wheat species and formation of ears is different: *T.turanicum x T.karamyshevii* - 2.1 %; *T. turanicum x T. durum* up to 60 %; *T. turanicum x T. sphaerococcum* and *T. spelta* forms up to 47 % of hybrid wheat. *T. turanicum x*. Formation of grains in its hybrids with other wheats is highly dependent on the diversity of species and environmental origin, but also on the direction of hybridization and selection of the second parent.

Compared to other countries, in Azerbaijan Turan wheat was mainly used for hybridization. Mustafayev İ.D. obtained *Turanikum-186* through the hybridization of local Azerbaijani *Turan* wheat and *melyanopus* variety of different species of the local hard wheat of Nakhchivan origin. This wheat relates to the diversity of species of *T. turanicum var. insigne* Perc. It differs from *Devedishi* sort for fluffy black awn, reddish scales, and the red grains. This sort has been regionalized for some regions of Uzbekistan and Kazakhstan.

The ears of this sort are awned, white-fluffy, with black awns, ears white and gray. Grains are white. It includes properties of Azerbaijan and Central Asian ecological groups. Spikes are cylindrical, sometimes bent. Ears are big (11-12cm), are 17-18 in number. Awns are irregular. Ear flakes are 15-16mm, 3mm wide, lancet-like. Grains are white, long and oval-shaped. The middle part of the grain is concaving (sickle-shaped). Grain length is 11-12mm. Weight of 1000 grains is 60 – 80gr. Grains are 100 % glassy. Forelock of the grain is sparsely fluffy. Plants' height is 116-120cm, bole strength is medium. In favorable climatic conditions when the ears are filled they are bowed down to the ground. If they are sown densely lay on the ground. The leaves are light green, long, wide and naked. Drought-resistant species. Resistant to fungous disease. Grains are of high quality, suitable for the production of pasta and confectionery products. Bread quality is assessed by 3.8 points. For the production of oven pita bread and lavash (bread baked of the thinly rolled dough) its quality is assessed by 5 points. Productivity of the sort is 35-40 quintals per hectare under favorable conditions. Productivity is higher in black and sandy soils. Depending on the climatic conditions there is probability of catching black germ diseases. According to mode of living it is half-autumn sort. In the experimental field of Nakhchivan SRS it was planted in May and gave the harvest. However, the productivity was low. If planted at the end of September or beginning of October, it gives good harvest. It is regionalized for irrigated lowland and highland zones.

The formation of the first generation of grains in hybrids of *Turanikum -186* with other varieties of wheat was found to be 25 % with *T. boeoticum*, *T. monococcum* 10 %, *T. montanum* 16.6 %, *T. dicoccoides* 25 %, *T. dicoccum* 29 %, soft wheat (*Gurgana* sort) 22 %, durum wheat (*Sevinj* sort) 26 %, *Zogal bugda* 78%, and the probability of survival of these grains variety is higher (12-85 %) (Fig.1).

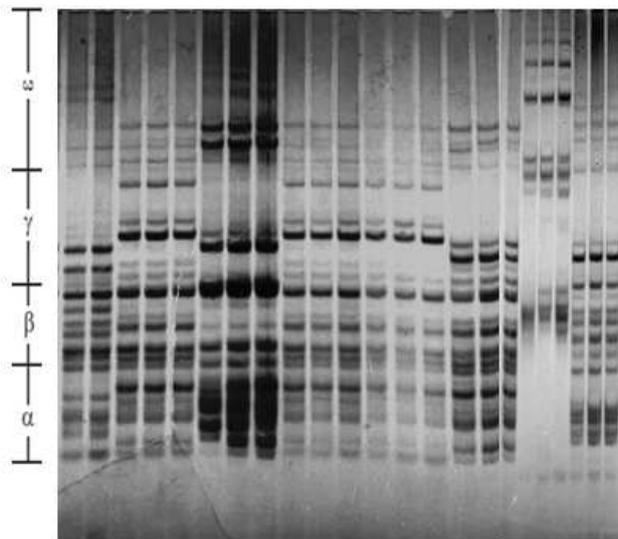


Fig. 1. Ears of the turanoid wheat: 1-Turanicum - 186 ; 2-3- Devedishi (Azerbaijan); 4- Turatish (KT - 0015, Uzbekistan ); 5-- *T.dicoccum var. rufum x S.segetale* (Nakhchivan *KT* - 0104).

Turan wheat has been hybridized with *Ae. cylindrica*, *Ae. triuncialis*, *Ae.biuncialis*, *S.segetale*, *S.montanum* species.

The *Turanikum-186* was hybridized with Bol bugda, (*Forte x Caucas*) $F_8$ , (*Sava x Albidum - 24, F\_6*), (*Turanikum - 186 x Zogal wheat*)  $F_7$ , *Bezostaya - 1* and others.

On the basis of spectrum of the gliadine proteins of  $F_2$  generation grains of (*Turanikum - 186 x Zogal bugda*)  $F_{12}$  x (*Forte x Caucasian*)  $F_6$  stable hybrid couple was developed durum and soft wheats. In this hybrid population weight of 1000 grains was 55.6g (46.5 – 73.2g). According to the morphological characteristics it has been formed durum, spelta, turgidum and the compact varieties of wheat, in addition, developed the intermediate forms with the characteristics of different species that has not been used in hybridization. According to the electrophoreogram spectrum it was defined that the spectra taken from individual grains is very similar. For example, there are spikes that have tetraploid, while some ears have hexaploid (spectra synthesized by D genome). Electrophoreograms of Turan wheat with various ecotypes were compared. As can be seen from the electrophoreograms Azerbaijan, Uzbekistan, Turkey-based *Devedishi* and *Turatish* sorts have the same origin and the spectrum similarity between them. However, the analysis of the gliadine fraction of grains taken from over 100 plant varieties showed that the pollination in the sowing areas had formed population of turanoid forms with different spectra (polymorphism according to the spectrum of the protein gliadine). Among the Turan wheat in the gene pool the presence of wheat with various spectrum proves that the turanoid forms are of different origin. Turanoids appear during the artificial and the hybridization in natural conditions. Some spectrum of *Turanikum* wheat is very similar to the spectra of *T.dicoccum* collected from Nakhchivan (Fig.2).



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

**Fig. 2.** Gliadin patterns (Electrophoreograms) of the wheat: 1,2 - *T.sphaerococcum* (Azerbaijan); 3,4,5 - *Turanicum 186* (Azerbaijan); 6- *Devedishi* (Azerbaijan); 7 -8- *Turatish* (Uzbekistan); 9,10 - *Turatish* (KT - 0015, Uzbekistan); 11,12- *Turan wheat* (Irak); 13,14-*Turan wheat* (KT -0016, Turkey); 15-16- *Turatish* ( Turkey); 17- *Turan wheat* (KT - 0012, Iran); 18, 19,20-*Secale segetale* (kS 0012); 21, 22, 23- - var. *turanoleucurum* Must.



**Fig. 3.** The ears perspective wheat of gained hybrid pair of the turanicum: A- *Ufuk*- [(*Zoqal buqda* x *Turanikum-186*,  $F_4$ ) x (*T.dicoccum* v. *rufum* x *Turanikum-186*,)  $F_6$  x *Triticale*]; B - *Turanikum - 186* x *Tturgidum* var. *romosum*,  $F_5$ ; C - (*Turanikum -186* x *Jafari*)  $F_9$  x *Ae. triuncialis*,  $F_{12}$ . E- *T. turanicum* x *T.dicoccum* var. *rufum*,  $F_{10}$ ; D-(*Turanikum 186* x *T.dicoccum* var. *farrum*) x *Triticale*.  $F_{12}$ .

There is Rf- 0,167; 0,182- spectra with the high molecular weight in  $\omega$ -fraction of turanoids collected from sown areas under natural conditions, that these specters belong to rye (*S.segetale*). The spectra of Turan wheat with Iran ecotype also is similar to the spectra of *Turan* wheat imported from China's Sichuan province.

The comparison of spectra shows the kinship among the Turan wheats. However, hybridized with other species they have become divergent. The spectra of the wheat *Turanikum - 186* are similar with the spectrum of ancient *Turan* wheat of Uzbekistan, Turkey and Azerbaijan. There are also different spectra.

Turanoid type wheats mostly emerge from the hybridization of *T. dicoccum* and rye, *egilosekale* and *triticale*. This opinion is confirmed by the elongated form of grain, convex in the central part (hump, sickle-shaped) fluffy flakes of the spike, the gnarled axis of spike (1). During our experiments it has been developed the turanoid shape of wheat from the hybridization of *T. dicoccum* x *T. aestivum* and varieties of species and biotypes of Turan wheat from the hybridization of *T. durum* x *Triticale*.

*Turan* wheat genetically is very close to the variety of species of durum melyanopus wheat. In the first generation the grain forming from the wheat of hybridization (direct and opposite) is up to 85 %. Germination of hybrid grains - 73%, plants that have completed vegetation -100 %. In the second generation it is obtained plants with big and multi-grained ears.

Among the wheat developed from (*Zogal buqda* x *Turanikum - 186*) x *Triticale* -1986 hybrid pair has been synthesized the *triticale* with weight of 104-108 grams of 1000 grains that can be considered the world's biggest grain wheat.

*Turan* wheat was hybridized with various types of *Aegilops*. It has been developed fixed hybrids with egilopses collected in Nakhchivan (*Ae. columnaris*, *Ae. triuncialis*, *Ae. cylindrica*) and egilops - wheat amphiplods (Figure 3a). For the synthesis of big and multi-grained wheat hybrids *Turanikum - 186* was hybridized with ramose form *turgidum* wheat. Among the second generation plants it is developed different simple and branched types of wheat and intermediate forms (Figure 3b).

*Turanikum - 186* and its hybrids easily hybridized with hexaploid wheats (soft, short, Vavilov wheat, etc.). According to the morphological traits its hybrids formed with hexaploids rather closer to speltoids. However, unites the characteristics of both parents in it. In  $F_2$  generation mostly arise tetraploids with the *percicum* features. The electrophoreogram of gliadine fraction of protein of  $F_1$  generation grains proves that they have co-dominant inherited quality.

The external appearance of most forms of grains of Turan wheat (sickle-shaped) is similar to *dicoccum* grains. Identity in some of the spectra of the protein gliadine fraction of grains proves the phylogenetic relationship of these *dicoccum* wheat sorts. Hybrids of forms which have spectra with hexaploid wheats are is mostly *dicoccoid* type in  $F_2 - F_3$  generation in terms of morphology.

## 4. Conclusions

As a result of hybridological research and electrophoresis analyses of gliadine protein we can come to the conclusion that *T.turanicum* Jakubz. and *T. polonicum* L. are similar in origin. Identity in origin of *T. turanicum* and *T. polonicum* was confirmed by other authors according to the DNA analysis [8, 10, 11]. Being of rye one of the parental forms of *Polonium* wheat has been proven by us.

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